JULY, 1916

15 CENTS

The Electrical Experimenter

POPULAR ELECTRICAL NEWS ILLUSTRATED

LARGEST CIRCULATION OF ANY ELECTRICAL PUBLICATION

When There's Trouble Getting In Tune—

with a sender—(you sometimes have it with even the most complete outfit)—you get into a certain habit—if your receivers are Brandes. It's the habit of looking *elsewhere* for the cause of the trouble.

BRANDES WIRELESS RECEIVERS

get you into the habit of always expecting the highest efficiency—and getting it,—getting increased range, clearer signals, strengthening of weak, long-distance signals without over-emphasis of nearby ones. One great secret of this Brandes efficiency is **perfectly matched tone**—both receivers toned exactly alike.

But there are other secrets too. Send 4 cents for Catalogue E which explains matched tone and all the other points of Brandes superiority. Every operator—professional or amateur—needs this book. Send today.

"Superior" Model Brandes Head Set, Price Complete, $5.50. Try it.

C. BRANDES, Inc.
Wireless Receiver Specialists
Room 814, 32 Union Square, New York, N. Y.

N. B. We cannot sacrifice Brandes quality—hence the slight advance in prices on all Brandes Receivers, necessitated by the present high cost of all raw materials.

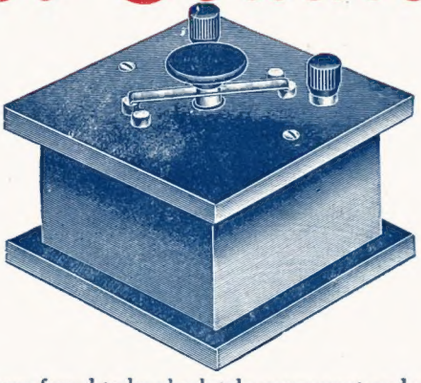
Tel-Radion

Permanent, instantaneous, constant

No batteries needed

No operating expense

No set screws or fine adjustments



No lost messages

No static interference

No delays or interruptions

Always reliable and efficient

It never fails you

THE only wireless detector that has been found to be absolutely permanent and needing no adjustment at any time. After severest tests found to be the only permanent wireless detector that upheld its advertiser's claims.. You can jar and kick the Tel-Radion, but you cannot knock it out of adjustment nor destroy its sensitiveness.

Don't be misled into buying a so-called "permanent" detector whose only attraction is its low price. For a few pennies you can construct the same type yourself. Seal up a piece of crystal after locating a sensitive spot on its surface. He is a novice who doesn't know the secret. Every operator knows how unsatisfactory it is in operation.

We will welcome a comparative test with any detector on the market by an expert, and we challenge anyone to disprove any of our claims. The Tel-Radion has been tested and approved by the experts of some of the largest commercial wireless stations in America. Especially recommended for shipboard and field work or any location subject to jars and vibrations.

Don't throw your money away on toys. Convince yourself at our expense. We pledge ourselves to refund the purchase price of the Tel-Radion if not satisfactory.

The Tel-Radion is the best permanent detector on the market. The Tel-Radion permanent wireless detector is enclosed in a highly polished mahogany cabinet. Size 4½ x 4½ x 3 inches, equipped with a duplex rotary switch, all metal parts silver plated. Prepaid to any part of the United States. Price **$5.00**

NOTE OUR GUARANTEE

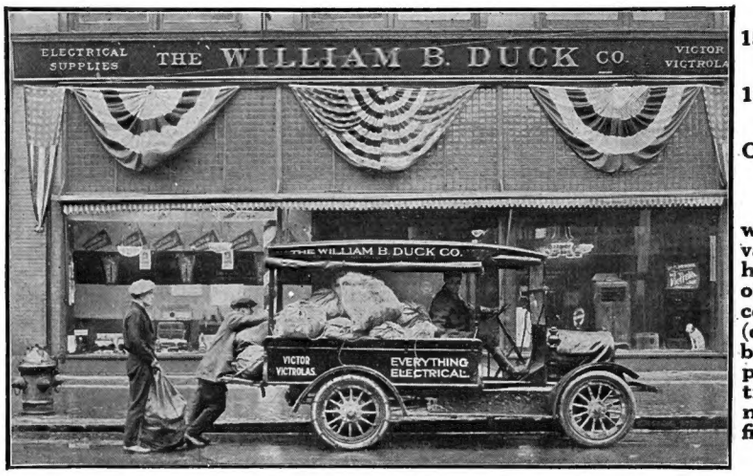
We guarantee the Tel-Radion to be superior to any other detector advertised as "permanent" or will refund your money. Equip your station with a Tel-Radion and lift it out of the amateur class. *Send for descriptive literature.*

TEL-RADION CO. **32 Union Sq., New York City**

DUCK'S NEW BIG No. 10 300-PAGE ELECTRICAL and WIRELESS CATALOG

MORE THAN EVER JUSTIFIES YOUR VERDICT
THAT IT IS THE *ONE* CATALOG WORTH WHILE

15,000 of our catalogs ready for delivery to eager electrical and wireless enthusiasts in all parts of the world. One of ten consecutive shipments of catalogs to our patrons during last November.



150 pp. Wireless Instruments.

150 pp. Electrical Supplies.

Over 40 pp. of Wireless Instruments.

Only 8c. in stamps will bring this unrivalled catalog to your home. The great cost of catalog and the exceptionally low prices (oftentimes fully 25% below usual retail price) prohibits its distribution otherwise. You may deduct the 8c. on first $1.00 purchase.

WHAT OUR BIG CATALOG CONTAINS

150 pp. Wireless Instruments, magnet wire of all kinds, raw material, storage batteries, telegraph instruments, battery motors, commercial motors and generators, sewing machine motors, telephones, step-down transformers, massage vibrators, bells, push buttons, auto accessories, flash lights, hand lanterns, auto and miniature lamps, Xmas tree outfits, voltmeters, ammeters, lighting plants, Victrolas, air rifles, electric aeroplanes, model builders, electric railways, electrical and mechanical books and general electrical supplies.

The William B. Duck Co., 230-232 SUPERIOR ST. TOLEDO, OHIO

New 1916 Edition Wireless Manual A9

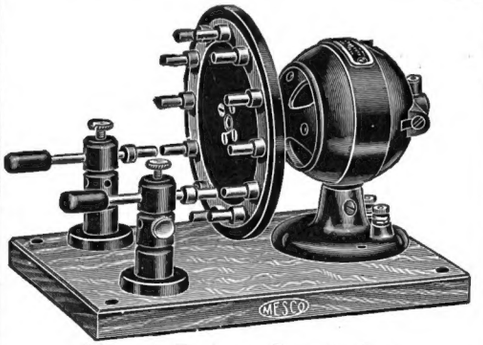
READY MAY 1st, Send 10c. for It

YOU WILL GET YOUR 10 CENTS BACK ON AN ORDER FOR $1.00

New diagrams. New matter. Everything brought up-to-the-minute. Most complete Manual as well as list of up-to-date, reliable wireless goods. We manufacture a lot ourselves and handle the very best that others make.

Our Pocket Electrical Catalogue W28, 248 pages, mailed on request. This catalogue contains practically everything in general use in the electrical line and is in fact a small pocket encyclopedia of electrical goods information.

EVERY ONE SHOULD HAVE A COPY OF BOTH



Mesco Rotary Spark Gap

Emits a high musical note. Can be heard at greater distances than the note from the stationary type. Cannot be mistaken for static or other atmospheric disturbances. Produces pure wave of low damping decrement. Increases transmitting efficiency 20 to 30 per cent.

The rotating member has twelve sparking points mounted on a hard rubber disk and is carried on the motor shaft. Can be used on our spark coils or transformers up to 1 K. W. Has two stationary electrodes with special adjusting devices.

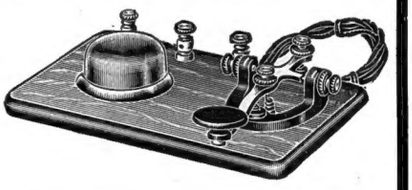
Our Globe Motor is used. Will operate on 110 A. C. or D. C. circuits; speed of 4,500 R.P.M. Also made with our Globe Battery Motor, which can be operated on a six-volt circuit.

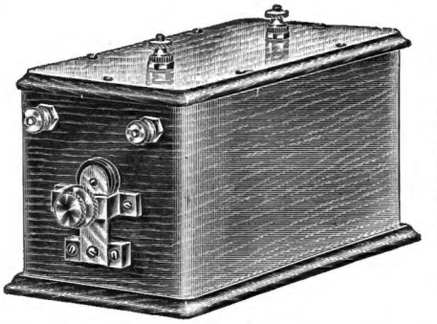
List No.		Price.
222	Mesco Rotary Spark Gap, 6 volt	$12.00
223	Mesco Rotary Spark Gap, 110 v., A. C. or D. C.	13.00
216	Rotary Unit Only, with two Stationary Electrodes for 3/16 inch shaft	5.00

Mesco Wireless Practice Set

Comprises a regular telegraph key, without circuit breaker, a special high pitch buzzer, one cell Red Seal dry battery, and four feet of green silk-covered flexible cord. The main object of the set is to enable the beginner to master the wireless code, and the buzzer reproduces the sound of the signals of the most modern wireless stations perfectly.

List No.		Price.
342	Wireless Practice Set, with battery and cord	$1.88





Mesco Wireless Spark Coils

Have low current consumption. Best to operate on dry batteries. Contact points of heavy platinum iridium. Has primary condenser in case. Made for wireless work. Permits of close tuning. Spark at interrupter reduced to a minimum; spark is heavy; made in ¼-inch to 4-inch sizes. Our Manual gives all the technical points.

List No.		Price.
462	Spark Coil, 1 inch; can be operated on 6 Red Seal dry batteries	$5.40

No advance in price of coils yet, although price of material is higher.

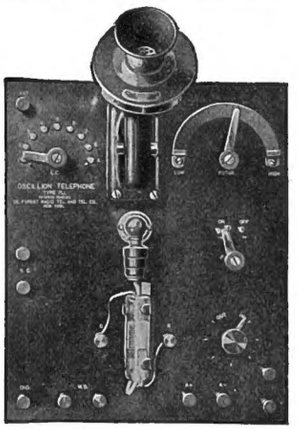
17 Park Place - - - New York
114 S. 5th Avenue - - Chicago

MANHATTAN ELECTRICAL SUPPLY CO.

1106 Pine Street - - St. Louis
604 Mission St., San Francisco

New De Forest Radio Telephone Transmitter

For years inventors have tried in vain to produce a reliable, commercial wireless telephone. The direct current arc was unstable and noisy. The speech was indistinct. An expert was needed to operate the arc.



It is entirely fitting that Dr. De Forest should have developed his famous AUDION into a generator of high frequency currents of absolute constancy and thorough reliability.

The arc is completely eliminated. The oscillion or audion generator replaces it, providing a practical, commercial radio telephone of low cost, low operating expense and simplicity. The speech is at least as clear as a wire telephone, if not more so. The set remains in adjustment indefinitely.

We offer radio telephone sets to cover from one to 150 miles, either transmitting sets alone or complete stations.

APPLICATIONS

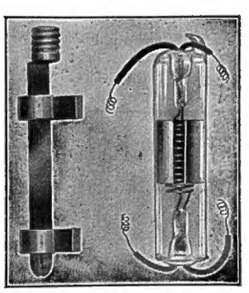
For yachts, house-boats, commercial ships, barges, tugs and lighters; for private and amateur use; for intercommunication between islands; for power transmission companies; for railroads; and a thousand other uses.

Low Initial Cost Low Operating Cost Thorough Reliability
Clear, Distinct Speech No Special Operator Required

Enclose stamp for new bulletin F16 on Oscillion Type Radio Telephones

THE DE FOREST AUDION

"There is only *one* Audion—the De Forest"



THE GENUINE DE FOREST TUBULAR AUDION

Is sold separately to any amateur who prefers to build his own Audion Detector **Price $5.50**

Adapter 40 cents extra.

Get the Bulletin (X16)

MOST SENSITIVE

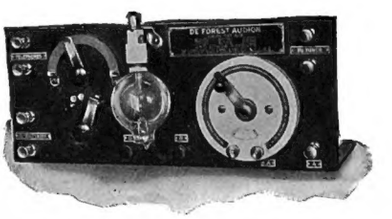
The Bulletin of the U. S. Bureau of Standards states that the De Forest Audion is fully 50 per cent. more sensitive than any other known form of detector (Vol. 6, No. 4, page 540).

MOST RELIABLE

It is not affected by mechanical vibration nor burned out by static or the transmitting spark. It never fails at the critical moment.

The detector is the heart of the receiving set. Why waste valuable time on an insensitive, unreliable detector?

The genuine De Forest Audion is now within the means of every operator.



THE TYPE R59 DE FOREST AUDION DETECTOR

Incorporates the Audion Bulb and the genuine De Forest patented circuits with the most approved accessories needed to form a complete detector.

The most popular Audion Detector ever offered. **Price $14.00**

Get the Bulletin (M16)

SEND FOR BULLETINS X16 AND M16 DESCRIBING AUDION

Detectors, Audion Amplifiers and Audion Receiving Cabinets

DE FOREST RADIO TELEPHONE & TELEGRAPH CO.

101 PARK AVENUE -:- NEW YORK, N. Y.

Makers of the Highest Grade Receiving Equipment in the World

The Electrical Experimenter

233 Fulton Street, New York.

Published by Experimenter Publishing Company, Inc. (H. Gernsback, President; S. Gernsback, Treasurer; M. Hymes, Secretary), 233 Fulton Street, New York.

Vol. IV Whole No. 39 **JULY, 1916** **No. 3**

ANNOUNCEMENT

AS will be noted the price of *The Electrical Experimenter* has been increased from ten to fifteen cents per copy beginning with this issue.

We have hesitated for months to take this important step, but circumstances over which we have no control finally forced us to increase the price, if we were to continue publishing your magazine.

The costs of producing magazines have gone up from 80% to 120%, due to the extraordinary conditions with which the publisher has to contend today. We will only enumerate a few here:

Our printing costs us 24% more this year than last year, due to higher labor costs as well as to the prodigious increase in price of all inks.

On account of the enormous demand for all print papers, there has been a constant shortage of supplies for several months. The same paper which cost us 3.65 cents a pound last year now costs 4.90 cents a pound—an increase of over 35%! The same paper in the open market now brings 9 cents a pound, an increase of 123% over last year!

Nor is this all. On April 3rd all the photo-engravers, practically throughout the country went into a combine, raising their prices in a truly astonishing manner. Line-cut engravings which cost us 40 cents previous to April 3rd now cost us $1.00 apiece, a little matter of 125% increase. Half-tone engravings (photographic reproductions) costing us $1.00 each before, now stand us $2.00 apiece—increase 100%. And these are only the prices for the smallest possible engravings. On the larger ones our cost is of course much higher. As an illustration take the large half-tone engraving on page 153. The usual price heretofore was $3.15. It costs us $5.25 now! The reader may compute to his own satisfaction just how much such an increase amounts to on the two hundred odd engravings appearing in this issue.

Summing up, there is scarcely an item connected with this publication that does not cost us anywhere from 55% to 200% more this year than last. At this moment, copy for copy, *The Electrical Experimenter* costs us 82% more to produce than a year ago. Nor is there a favorable outlook that prices will soon recede. Quite the contrary, all materials as well as labor are steadily increasing and it will probably be years before the markets will have readjusted themselves.

Were it not for our advertisers, the increase of 5 cents per copy would not come anywhere near reimbursing us for our higher costs. As matters stand at this moment, we are really worse off now, in point of revenue, at 15 cents a copy than at 10 cents a copy last year.

Most publishers at the present time are cutting down the volume of their publication, to meet the staggering increases and they cannot be blamed for it.

We, on the other hand, will steadily *increase* the volume, though we probably will not make any profits whatsoever for a year or more to come. This issue already has been enlarged eight pages; further issues will be enlarged still more. We will not permit ourselves to lower the present high standard of your magazine. On the contrary, each number will show improvements over the preceding ones.

We are now preparing a series of new supplements the first to appear in the early fall. The large photogravure of Mr. Marconi in the August, 1915, issue has brought forth so many requests for more such pictures, suitable for framing, that we decided to add the following to the list: Edison, Tesla, Fessenden, DeForest, Hertz—all famous electrical men—to adorn your den, your laboratory, your wireless station, or your workshop. These pictures, printed on expensive art paper by the rotogravure process, cannot be told apart from an art photograph. Photogravures such as these are sold at 25 cents apiece at art stores. They will be given free with forthcoming issues of *The Electrical Experimenter*. As the demand for your magazine is bound to be heavy, we suggest placing your order with your newsdealer at an early date.

For a short time the subscription price of *The Electrical Experimenter* will remain $1.00 a year ($1.50 Canada and Foreign) in order to enable readers to take advantage at the old rate. No subscription can be accepted for more than five years at this rate.

The new rate will be $1.50 a year ($2.00 for Canada and Foreign).

We wish to take this occasion to thank our readers for their splendid support in the past and we earnestly pray that they will stand by us during a trying period, which is as extraordinary as it was unforeseen.

In return, we pledge our word to spare no expense or effort to make *The Electrical Experimenter* the one magazine that you will welcome month after month like an old and staunch friend, the one magazine that has the latest and most exclusive news, months ahead of any other publication, and the one magazine serving its readers first, last and all the time in the pursuit of true light and knowledge, not being the servant of any special interests, nor building a large circulation at the expense of the present editorial policy.

In turn may we ask you to speak a good word for your magazine once in a while?

THE PUBLISHERS.

Please post in a conspicuous place.

DEPARTMENT OF COMMERCE
WASHINGTON, D. C.

SHORTAGE OF PAPER MATERIAL

Save Your Waste Paper and Rags

The attention of the Department of Commerce is called, by the president of a large paper manufacturing company, to the fact that there is a serious shortage of raw material for the manufacture of paper, including rags and old papers. He urges that the Department should make it known that the collecting and saving of rags and old papers would greatly better existing conditions for American manufacturers.

Something like 15,000 tons of different kinds of paper and paper board are manufactured every day in the United States and a large proportion of this, after it has served its purpose, could be used over again in some class of paper. A large part of it, however, is either burned or otherwise wasted. This, of course, has to be replaced by new materials. In the early history of the paper industry publicity was given to the importance of saving rags. It is of scarcely less importance now. The Department of Commerce is glad to bring this matter to the attention of the public in the hope that practical results may flow from it. A little attention to the saving of rags and old papers will mean genuine relief to our paper industry and a diminishing drain upon our sources of supply for new materials.

A list of dealers in paper stocks can be obtained from the local Chamber of Commerce or Board of Trade.

WILLIAM C. REDFIELD, Secretary.

Our readers can do much towards helping to reduce present abnormal high paper costs by heeding the urgent call of our Government.

THE ELECTRICAL EXPERIMENTER is published on the 15th of each month at 233 Fulton Street, New York. There are 12 numbers per year. Subscription price is $1.00 a year in U. S. and possessions. Canada and foreign countries, $1.50 a year. U. S. coin as well as U. S. stamps accepted (no foreign coins or stamps). Single copies, 15 cents each. A sample copy will be sent gratis on request. Checks and money orders should be drawn to order of THE EXPERIMENTER PUBLISHING CO., INC. If you change your address notify us promptly, in order that copies are not miscarried or lost. **A green wrapper indicates expiration. No copies sent after expiration.**

All communications and contributions to this journal should be addressed to: Editor, THE ELECTRICAL EXPERIMENTER, 233 Fulton Street, New York. Unaccepted contributions cannot be returned unless full return postage has been included. ALL accepted contributions are paid for on publication. A special rate is paid for novel experiments; good photographs accompanying them are highly desirable.

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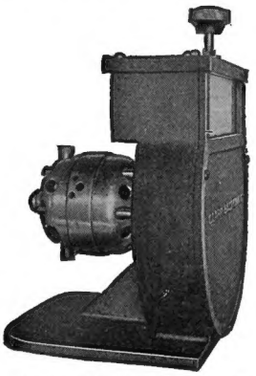


Semi-Quenched Cambridge Rot. Discharger

The Cambridge Semi-Quenched rotating spark discharger is completely enclosed, has glass-covered inspection opening, variable speed motor of the highest quality and operates on any wireless transformer.

Price $32.50

Charge Storage Batteries

from alternating current at home, garage, or workshop with our Electrolytic Rectifiers. Safe, clean, economical.

Price $7.50 and up

JUST BECAUSE

We build high grade apparatus and avoid making things so cheap they can't be good

DON'T THINK

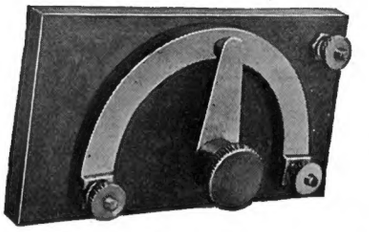
your small orders aren't welcome. Your order for a binding post or nut will receive the same attention as a larger one, the best service we can give.

Our two catalogs, aggregating 160 pages, contain not only a complete list of Radio and Electrical apparatus but also many small parts and raw materials often difficult to obtain.

Both books sent for 6c postage

CLAPP-EASTHAM CO.

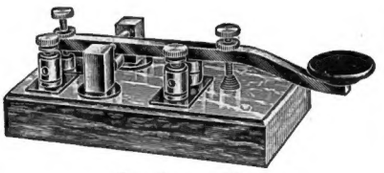
141 Main Street, Cambridge, Mass.



Graphite Potentiometer

Graphite Potentiometer resistance 1000 ohms carbon contact point.

Price $2.25



The Boston Key

for breaking heavy currents is unequalled. Silver points, nickel-plated brass metal parts, marble base. If you want satisfaction refuse imitations.

Price $6.50 and up

Free Excursion to New York

A REMARKABLE OFFER

WHETHER you live in Portland, Maine, or in Portland, Oregon, you now have the finest chance of a lifetime to come to the famous Metropolis for your summer's vacation, *without cost to you.*

The Publishers of the ELECTRICAL EXPERIMENTER will pay your railroad fare to New York and back to your home. Hotel accommodation will be provided at a well-known New York Broadway hotel for two weeks. You may come any time between July 1st and September 30th. Just think what a chance! You always wanted to come to New York, the city of wonders, the largest and most marvelous city in the world. Will you come?

READ OUR OFFER

All we ask is that you visit your friends and acquaintances and obtain their subscriptions at $1.00 a year. Almost everybody you can think of wants to read such a bright up-to-date publication as the ELECTRICAL EXPERIMENTER. Nearly everyone has money to spare and, with a little urging, your friends and even strangers may be persuaded to subscribe. Once you get the knack you can take from eight to fifteen subscriptions a day. (Upon request, we will furnish you free with a short treatise on how to get subscriptions.) By soliciting from one to two hours a day, during your spare time, you will surprise yourself how many people you will be able to convince that they should read the ELECTRICAL EXPERIMENTER.

After securing the money send us the cash or Money Order and be sure that the envelope and letter are plainly marked *"Subscription Contest."* You will be credited with every subscription you send in. A one year's subscription counts for one point, a two years' subscription for two points, and so on. You may subscribe for three or five years yourself by sending in three or five dollars. In that case you will be credited with three or five subscriptions as the case may be.

The individual sending in the largest number of subscriptions between now and closing date will be entitled to the free excursion to New York as described above, or one of the other prizes we mention below.

RULES

1st. All subscriptions must be sent to us within twenty-four hours after receipt of money.
2nd. The full subscription price—$1.00 in United States, $1.50 in Canada and foreign countries—must be remitted.
3rd. The condition previously published is omitted. Prize will be given to winner regardless of how many subscriptions are sent in.
4th. Anyone, either sex, if over 12 years old, may participate in the contest.
5th. Contest closes at 12 o'clock noon, June 30th, 1916, at which time the last subscription must be in our hands. The winner will be notified at once.
6th. Winners will be announced in our August issue.
7th. Subscription agencies are not eligible to compete.
8th. If two or more persons are tied for any prize each will receive the prize tied for.

ADDITIONAL PRIZES

2nd Prize. A $50.00 Wireless Outfit (Sending and Receiving).
3rd " A $20.00 twenty-year guarantee, 17-jewel gold watch.
4th Prize. A $12.00 "Ingento" 2¼ x 3¼ folding camera.
5th " A $10.00 ten-year guarantee, 7-jewel, gold-filled watch.

IMPORTANT! **Anyone not winning a prize and sending in more than 5 subscriptions will be paid a commission of 20 cents on each new subscription he sends in. Commissions will be paid at the close of the contest.**

Someone is going to win each of the prizes. Will it be you? If you believe in yourself and in the ELECTRICAL EXPERIMENTER, you will succeed. Better start right now and convince yourself how easy it is in these prosperous times to get subscriptions for a worthy magazine. Address all letters

"SUBSCRIPTION CONTEST"

Experimenter Publishing Co. 233 Fulton Street, New York City

THE ELECTRICAL EXPERIMENTER

H. GERNSBACK EDITOR
H. W. SECOR ASSOCIATE EDITOR

Vol. IV. Whole No. 39 JULY, 1916 Number 3

A Long-Distance Electro-Mobile of the Future

By Hubert A. McIlvaine

NOW that the cost of gasoline has so much increased many are wondering what will become of the auto if the fuel cost continues to rise. It is said that electric automobiles are too expensive, the storage system too inconvenient and bulky, and altogether unsuited for cross country tours. It is the purpose of this article to advance a plan whereby the electric auto may be made, not only more convenient and reliable, but also more inexpensive than any other vehicle.

According to this plan several of the most prominent and best suited highways, running east and west across the continent, and a like number running north and south, or roads between important commercial centers, should be selected, and great power plants should be erected along these. High tension "feed" wires should connect these power plants and run along the whole length of the highways. There should be two sets of trolley wires, one on each side of the road. It will of course be necessary to use two trolley wires, as there are no rails for a return circuit. The voltage of the trolley wires must, necessarily, be low, in order to prevent all accidents. Step down transformers should be placed at convenient intervals, along the high voltage feed wires, and these should supply a voltage of from 80 to 110 (as is found best) to the trolley wires.

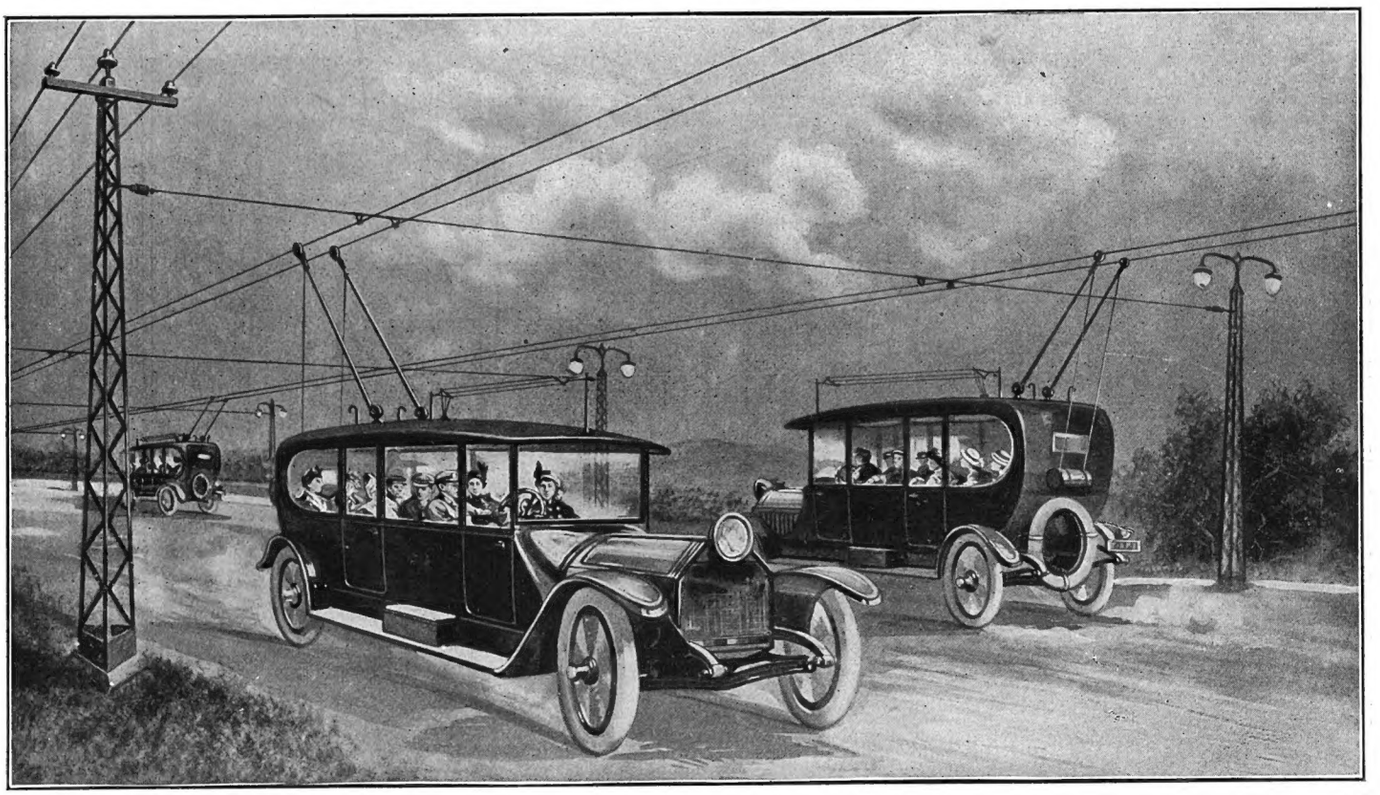
The automobile should be equipped with a storage battery large enough to run the car for a few miles, in order to get to the trolley.

The power plants could be owned by the state or nation, and kept up in the same manner as the highways are kept. Then each car could be equipped with a watt-meter, which should be sealed, and it should be an unlawful act to break the seals. Then, at different set times, the cars should be run into an office, in the county seat, perhaps, and the watt-meters read, set back, and new seals affixed. The current used could thus be paid for in much the same manner as taxes are paid.

If, for instance, a man living in Pennsylvania wished to go to St. Louis some cold winter day all he would have to do would be to go out to his garage, and after getting his provisions ready, get into his electric Sedan and start. He would then run on his small direct current motor and storage system, with which he could probably make 20 miles per hour, until he struck the electrified highway. He would then pass under the right hand set of trolley wires and let his flexible jointed poles contact against the wires.

If necessary he could then use his large alternating current motor for charging his storage battery with a small direct current generator while traveling. Electric heaters to maintain a comfortable temperature within the car would be installed as a matter of course. At meal time he could pull out on one of the side roads constructed beforehand for the purpose, and cook his meals on electric heaters. Electric interior and exterior lights could, of course, be used on the car. A small wireless telephone might even be used to keep in touch with home or office.

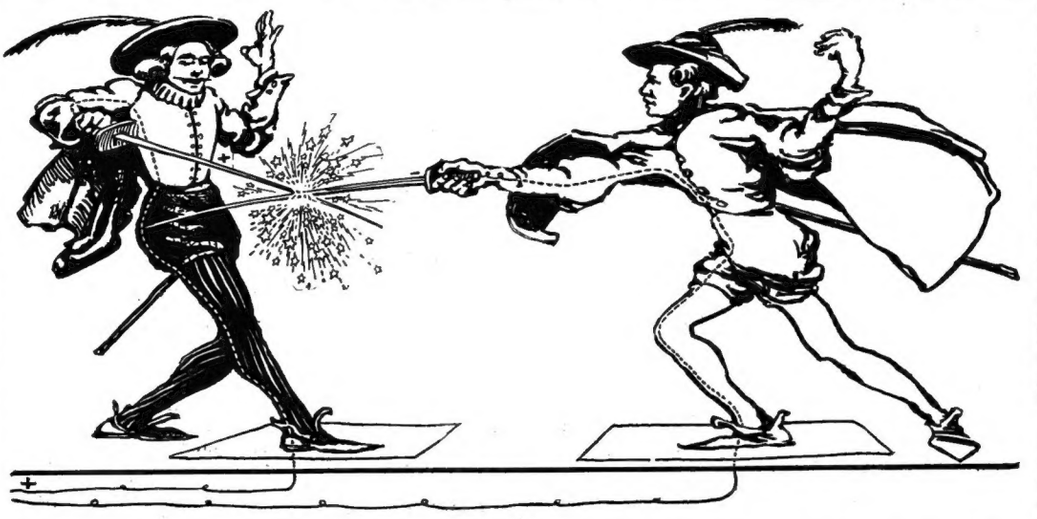
With a little experimenting this system could be made a very reliable, cheap and convenient mode of travel, besides being a paying proposition to the government and a benefit to the people.



A Long-Distance Electro-Mobile Which Takes Its Power Thru Two Specially Flexible Trolley Poles. A Small Storage Battery Runs the Motor While the Car Is Being Driven to the Nearest Electrified Highway. A Watt Hour Meter Measures the Energy Consumed.

Electricity's Part on the Stage

YOU are sitting in the darkened theatre, your eyes fixed on two characters who with swords unsheathed approach each other bent on avenging a wrong. It is Faust with its wonderful story that holds your attention and causes you to lean forward with bated breath. There is a thrust and a parry as the duel starts and the sparks fly from the swords; this is your first introduction to some of the unusual stunts that electricity does on the stage. Now these vivid sparks while startling and mysterious are not so mysterious after all. And surely neither Faust or Valentine are sources of enormous quantities of electricity. Instead they are mere mortals, each standing on a metal plate to which they made contact through metal heel plates. These metal heel plates are connected to their swords by a flexible cable running concealed up their legs. The source of current is the house lighting circuit connected to the metal plates through an inductive resistance allowing about 10 amperes to flow through the circuit when the swords touch. The sparks are simply what you would see when you open any switch carrying current, but in the midst of a tense scene on a darkened stage it is mysterious. Figure 3 shows the wiring diagram which is simple though effective.



When Valentine and Faust Thrust and Parry So Valiantly, Electricity Is the Power Behind the Flashes Which Sizzle between the Clashing Rapiers

But it is in the production of natural phenomena that the stage electrician is at his best. His artificial *sunrise* and *sunset* are rivals of nature that are simply magnificent, and their production is the height of simplicity. In series with the footlights, borders, and proscenium lights are adjustable resistances so interlocked that the different series of colored lights (there are five sets, white, amber, red, blue and green) are gradually lighted and extinguished. For instance, to produce a sunrise the greens and blues are gradually brought to half glow, then the red and amber follow with the first set dimming while of course the white is the final to simulate sunlight. For sunset the order is reversed, the whites being dimmed, while red and amber are brought to a glow, etc. Moonlight is only the light from the dimmed blue lights with just a trace of the green lights. But of course it takes an electrician of experience to handle the switchboard to get the maximum of results.

The storm scene gives the electrician his real chance to show his ingenuity, however. There, amidst the howl of wind, the patter of raindrops, comes a blinding flash of lightning. For instance, in "King Lear," there is a wonderful storm scene. The lightning plays around while peals of thunder shake the building, a bolt of lightning comes from the sky and strikes the tree to the left of the stage. There is a crash and where a tree stood before, there are only pieces. This scene when witnessed by an

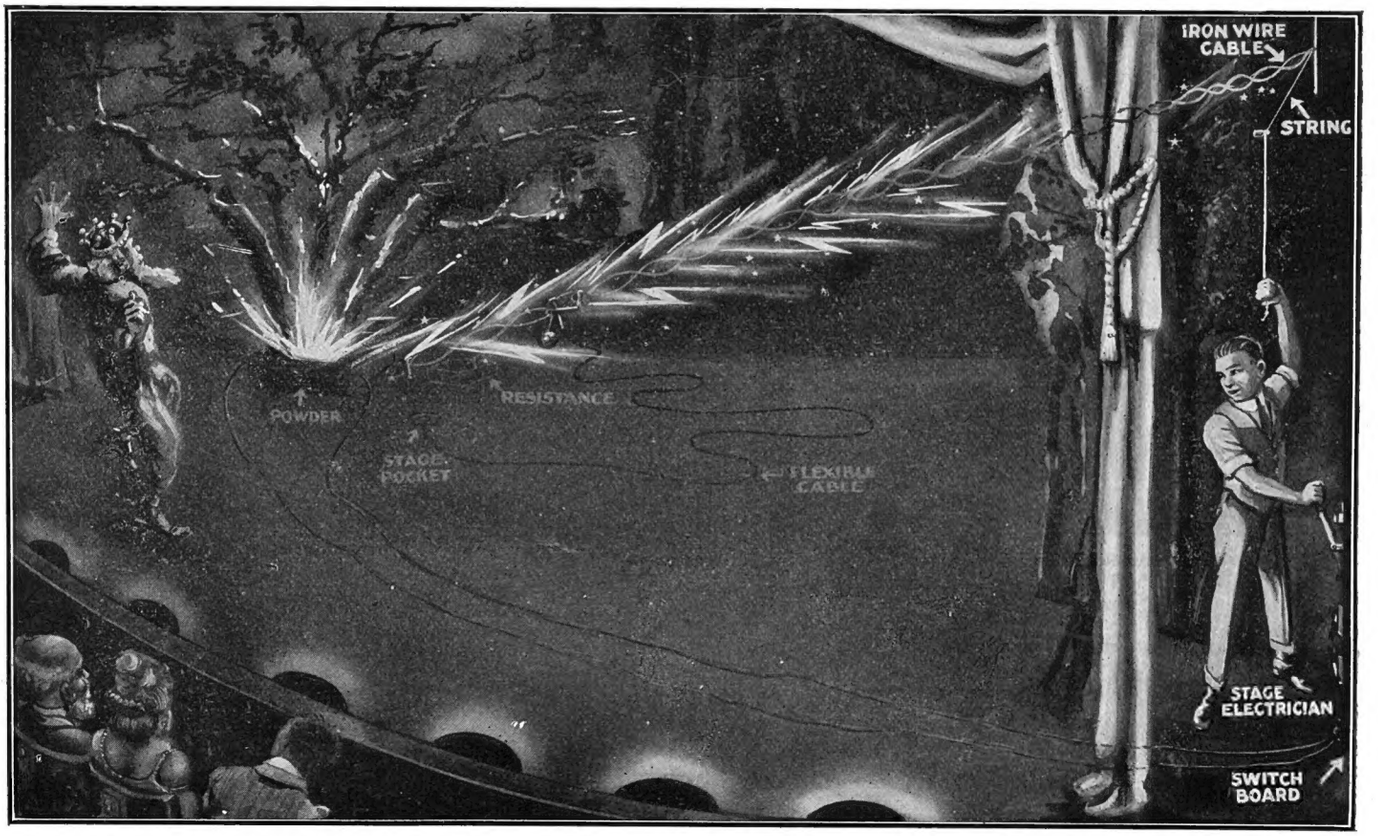


Fig. 1. Old King Lear Has a Perfect Right to Appear Surprised, when the Stage Electrician of To-day Can Produce a Lightning Bolt So Realistic as This

interested audience is hardly analyzed to find out how it is produced. Yet to the initiated it is simple. A circuit is run from the stage switchboard to a machine as in Fig. 1, while the apparatus is seen at Figs. 2 and 2A. The current supply and switch are of course at the switchboard and every time the circuit is broken there is a flash. On account of the machine depending on a solenoid A it requires direct current for its operation. The solenoid actuates the core B. When the core is drawn into the coil it brings with it a connection on a toggle joint raising a carbon electrode which touches an iron plate. As heavy current is flowing through the carbon and iron plate it is obvious that a flash is produced whenever the core is drawn into the coil. This flash is your stage lightning and several machines properly distributed produce wonderful effects.

But the bolt of lightning was not from such a contrivance, for you would distinctly say, "I saw a *bolt* of lightning." True, but it's just as simple. It consists of two concentric cables as in Fig 1, each being uninsulated and carrying current. The cable stretches from the *flys* to the tree and on a darkened stage it is of course invisible. On this cable rises a pulley with a projecting arm that carries carbon contacts to scrape along the cable making a series of vivid flashes. The contact is released by a stage hand in the *flys* at the right instant, and of course leaves a trail of flashes that travels too fast for even an inquisitive audience to understand the details. The tree is pulled apart by a ready stage hand and then when the bolt strikes, as far as the stage is concerned, it is simply an explosion of a small quantity of smokeless powder in a sheet placed in a box ignited by fusing a piece of fine (No. 30 or smaller) magnet wire. The essential of all these stunts, however, is their working in harmony and being timed to the instant.

Fig. 6. A Special Projecting Lantern with Which It Becomes Possible to Show Cartoons Being Drawn by the Artist

"Movies" play a big part on the stage, bigger than many people think, for without "Movies" the wonderful cloud scenes, tornadoes, etc., would be impossible. Of course, many of these scenes are produced on a rotary stereopticon plate and stereopticon lantern, but after all, those are modified "Movies," and to-day no stage could produce rippling water or water-falls without them.

Twinkling stars always have a fascination for the theatre-goer, but we wonder if they would be so fascinating if he knew they were only little flashlight lamps behind tiny holes in the back drop, and lighted and extinguished by an ordinary motor-driven sign flasher for a large stage or by hand on a small one! Of course, only one or two are lighted at a time and then only for an instant. The moon that you have watched rising is not necessarily a yellow glass globe, with a light in it, but more probably a stereopticon projection that is caused to rise by the change of focus and that changes its color by the use of dimmer-controlled colored lamps in the lamp of the projecting machine.

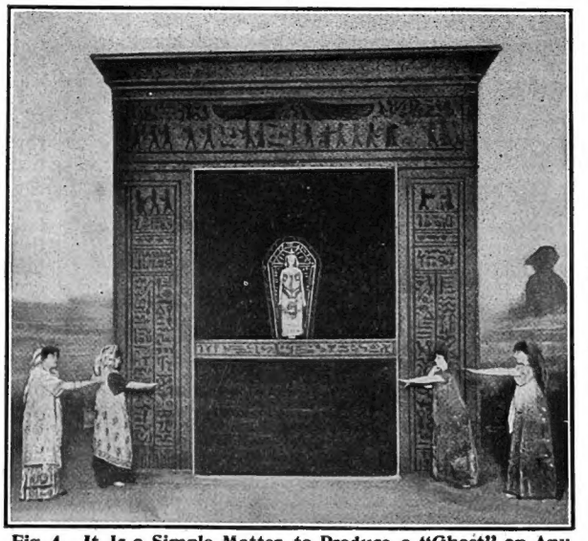


Fig. 4. It Is a Simple Matter to Produce a "Ghost" on Any Modern Theatre Stage

Sunlight streaming through stage windows is of course only the rays of a spot or "bunch-light" properly directed. Stage fire isn't dangerous either, for it consists only of some red, yellow and blue silk strips lighted by red lamps and agitated by a small electric fan. Perhaps it doesn't seem that as simple a scheme as this will produce realistic flames, but the fact remains that it does. (See Fig. 5.)

Yes, but stage *ghosts* you remark; surely anything so naturally mysterious must be almost as mysterious on the theatrical stage as in a haunted house. Well now, let us see Mr. Stage Electrician bring out his ready-made ghost and see if he is half as mysterious as we imagine. It does require the most extreme care as to the amount and kind of illumination that is employed, lest instead of a serious ghost scene there is produced a ridiculous farce. Probably the most successful way of showing ghost effects is the optical illusion method, performed substantially as follows: The actor who is to see the ghost is stationed in front of a fine gauze curtain and at the same time he is kept away from the lights. Where the actor sits, a small partition stage setting is placed, at the back of which a projecting arc lamp is set which contains a green lantern slide upon which the image of the person is placed who is to be brought before the audience as a ghost. When the ghost is to be shown, the electrician is given the signal and he extinguishes the stage footlights and in their place he lights up several blue lamps around the stage border, at the same time starting gradually his projecting light. At the start a green effect is produced on the screen due to the colored coating of the slide, and finally the ghost appears which is the projection of the image on the slide in the projector. Finally the slide is slowly removed, thus causing the ghost to fade away.

Fig. 5. Artificial Log Fires Operated by Electricity, Complete Many Elaborate Stage Settings

Our illustration, Fig. 4, shows a ghost produced by employing a mirror so placed before the audience that it will reflect the actor's image before this mirror, the latter being illuminated by a projecting lamp, throwing its rays upon the actor. With such an arrangement the ghost can be made to perform various stunts impossible of attainment with the previous method, unless a moving picture film is used.

Another important use of optics and electricity for stagecraft work is that of projecting sketches as rapid as they are made. Thus, for example, in moving pictures, oftentimes a man is seen dressed as an artist who is busily sketching on his desk, and just above the sketched picture appears. It seems as if you were watching him draw the picture. Lately, cartoons have been thrown on the screen by different moving picture companies. The apparatus used for projecting these sketched pictures is seen in Fig. 6. It consists of nothing more than an arc lamp enclosed in a glass-topped table. Its rays are projected upward through the table top upon which the artist sketches his picture. On the top of the table a small stand holds an achromatic objective lens for projecting the lines horizontally on the screen as rapidly as the artist draws the cartoons. The movies use this projecting apparatus in showing how fast cartoons are made.

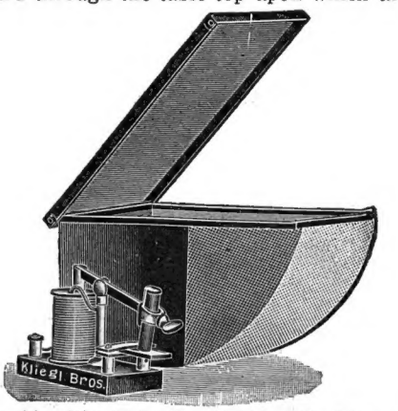


Fig. 2A. The Lightning Flashing Machine A Simple, Yet Effective Device

Surely electricity is playing many stage rôles and doing them more wonderfully

(*Continued on page 217*)

WIRELESS 'PHONES ON U.S. WARSHIPS.

Wireless telephone communication between ships for transmission of orders in movements at sea are in the process of development in the Atlantic Fleet in the maneuvers off Guantanamo.

Two different systems of wireless apparatus for telephone communication are being tried under the direction of Lieutenant William Furlong, Fleet Radio Officer, and other Radio Officers of the Fleet. Instruments are installed on the battleships *Wyoming, Texas, Florida* and *New York* and the object of the tests is to determine the reliability and adaptability of each to produce the desired results.

Secretary Daniels Radio-Phones to U. S. Battleship at Sea

ONE of the most inspiring tests of the wireless telephone recently took place when Secretary of the Navy Daniels called up the commander of the U.S. Battleship New Hampshire, first in Hampton Roads, Va., and later while she was steaming at sea.

The power to send wireless messages, more than anything else since the adoption of steam for motive power, has revolutionized naval strategy and made possible maneuvers not even dreamed of by the great naval commanders. The demonstration which took place at the Navy Department of the practical operation of the wireless telephone added the beginning of a new chapter to the great book, not yet finished, of communications at sea.

On that occasion Secretary Daniels, standing before the desk in his office, surrounded by officers of the navy and the army, by high officials, including the head of the scientific corps of the company which had developed the system, and by the newspaper men of Washington, received from Captain Bullard what to all appearances was an ordinary desk telephone. Without preliminaries, he asked as simply as if about to use the 'phone in an ordinary way: "Is that you, Captain Chandler?"

And in quite as matter of fact way, Captain Chandler from the U.S.S. New Hampshire, lying out in Hampton Roads, replied by wireless telephone: "Yes, Mr. Secretary, this is Captain Chandler. Have you any orders for me, sir?"

The reply was heard by the dozen or more guests, who were holding auxiliary receivers to their ears as plainly as if the captain had been talking over a wire from a nearby city.

Secretary Daniels gave a wireless order for the New Hampshire to proceed to sea and to expect further orders by wireless telephone the next morning. In response to the Secretary's inquiry, Captain Chandler said that he understood his instructions perfectly, and repeated them so nearly word for word that all the auditors knew that he on shipboard must have heard the Secretary quite as clearly as they had heard Captain Chandler.

The talk between ships and shore was continued, demonstrating the practical accomplishment of an object long sought. It seemed to those who watched and listened that a Prospero had by waving his wand called "the spirits from the vasty deep" to serve and a little incongruous that a man dressed in everyday clothes and wearing shell-framed glasses should in so simple a way, pledge the patriotic support of the corporation he represented to the navy to insure the mobilization of the communications over land and sea. That is what Mr. Bethel did; and Mr. Carty, the head of that company's scientific and practical force, the man who above all others had brought this event to pass, assured the guests that the United States Navy may now have a means of communication such as no other country can possess.

Incidentally the tests made the next day with the New Hampshire steaming at sea outside the capes confirmed the success of the new system, which is the logical outgrowth of earlier triumphs in sending wireless messages from Arlington to San Francisco, by means of the extremely efficient radio stations at these places.

Following the trial of the wireless telephone other tests were made by calling up, at a moment's notice, naval stations on the east, west and south shores of the country, and asking all sorts of military questions, to which answers given in military fashion were immediately received.

The battle of New Orleans was fought in 1815, two weeks after peace terms had been made, because the news had not been received from Europe. Although telegraph service on shore was established, it was not until after the civil war that a cable message could find its way from one side of the ocean to the other. Now, though the cables were cut, the messages would fly through the air across the seas, and although all wires were down, winged words would take their way all over the continent, traversing the distance in a fraction of a second.

The powerful government radio station at Radio, Va., popularly termed *Arlington,* was utilized for these tests. The apparatus is capable of being linked up with land lines, as in this instance, and has been used to form the major link in a line-radio-line test, i.e., where the ordinary telephone speech (transmitted over a line) was converted into radio waves, then reconverted into electric currents on a second telephone line. This demonstrates the marked flexibility of the system now used by the government.

It involves the use of several hundred evacuated glass bulbs, resembling huge tungsten lamps. These tubes act on the principle of the de Forest audion detector, and produce a considerable amount of undamped wave energy at radio frequency. The tubes, known as *pliotrons,* develop about ½ ampere of high frequency current each (1 k.w. each). To talk across the continent about 300 bulbs are necessary. They are all connected in parallel, and by a special transformer connection, it proves an easy matter to control the antenna output of about 70 kilowatts by means of an ordinary *Bell* telephone transmitter when speaking into it in the usual tone of voice. Such is the work being accomplished by the U.S. government and commercial radio experts, and it is hoped that this research will continue. Without a doubt the present equipment stands second to none, and let us trust that it will continue to be.

The radio branch for material or construction work is under the bureau of steam engineering, Admiral Griffin. The officer in charge is Lieutenant S. C. Hooper. Some of the material is purchased, but much is made in the government works, all under the specifications and designs of the department. The service, excellent as it is, does not satisfy the exacting men in charge. They are planning and striving to make improvements which will put the navy just a little further in front of all rivals, in the instruments for giving and receiving intelligence and for controlling the movements of the American fleet.

Talking to the U. S. S, New Hampshire, in Hampton Roads, by Wireless Telephone from the Navy Department, Washington. Secretary Daniels with Transmitter, J. C. Carty at His Extreme Left and E. N. Bethel at His Right. Capt. Bullard, U. S. N., Second to the Left of the Secretary

ELECTRIC DRY CELL SIGNAL LAMP VISIBLE 100 MILES.

E. G. Fischer, chief of the Instrument Section of the Coast and Geodetic Survey, Department of Commerce, has just completed the design and construction of a signal lamp which will be used during the coming summer in the mountainous regions of Idaho and Oregon on primary triangulation where the distance between stations is frequently as much as 100 miles. This lamp has been tested by the Bureau of Standards and is shown to be more than 150 times as powerful as the acetylene signal lamps which have been used for a number of years by the Survey. These acetylene lamps have been observed with the telescope over lines more than 120 miles in length. The new lamp is an electric one, with a specially designed filament, and the power is the ordinary dry cell. While no tests have been made on the field with the new lamp, it is expected that ordinary haze or smoke will seldom prevent observations. The Bureau of Standards has made careful tests of the new lamp and states that the larger sizes of this lamp are so powerful as to be scarcely comparable with the acetylene lamp.

Electricity is used extensively for operating private and commercial ice-making machines.

ELECTRICAL ENGINEERS HOLD 'PHONE MEETING SIMULTANEOUSLY IN 6 CITIES.

Fifty-two hundred persons in six cities —New York, San Francisco, Boston, Philadelphia, Chicago and Atlanta—convened on the evening of May sixteenth in the first national meeting ever held over the telephone, when the American Institute of Electrical Engineers used this method of holding a joint meeting of its members.

Greetings were sent from the New York gathering, 1,100 strong, which met at the Engineering Societies' Building, No. 33 West Thirty-ninth Street, by Alexander Graham Bell, inventor of the telephone; by Thomas A. Watson, who was associated with him in his experiments and the first man ever to receive a message over the telephone, and by Theodore N. Vail, president of the American Telephone and Telegraph Company, to the members of the association assembled in the other cities.

Mr. Bell said: "I am glad to be alive. Not many men live to see the fruition of their own thoughts and live even beyond that. The telephone has gone far beyond me. I hope to live some time longer and see many more improvements over the simple invention I made." His remarks were greeted with applause *from all over the United States.*

John J. Carty, retiring president of the institute, read a telegram over the telephone to the 5,000 members which had been received from President Wilson. The telegram read:

"May I extend my warm congratulations to the members of the institute upon the unique meeting in which it has gathered its members in Boston, New York, San Francisco, Chicago, Philadelphia and Atlanta. It is with genuine satisfaction that I avail myself of this occasion to express my own deep appreciation of the work of the institute in the developments of the country's resources."

Harrison J. Ryan, in San Francisco, proposed a resolution of thanks to those who had made the meeting possible. Charles R. Cross, in Boston, seconded the motion, but J. H. Tracy, in Philadelphia, broke in with an amendment suggesting that the secretary be ordered to send a copy of the resolutions to each of the speakers. Bancroft Gherardi in New York, seconded the amendment, which was then assented to by Messrs. Ryan and Cross.

"Are you ready for the question?" asked President Carty. "Then all in favor say 'aye,' those opposed 'no.'"

Across the wire came a loud "aye!" from the meetings.

In making the address of the evening, President John H. Finley of the University of the State of New York prophesied even more wonderful inventions for the future. The time may come, he said, when some delicate instrument will be able to record wave motion so that future generations will be able to listen to the prayers of Columbus as he guided his ships toward the New World or hear the Egyptian kings of old speak, or even know the color of the eyes of Helen of Troy.

Among others present were Professor Pupin of Columbia, C. le Maistre, who recently arrived from London as representative of the British Engineering Societies; Professor Scott of Yale, President Humphreys of Stevens Institute, and President Bethell of the New York Telephone Company. At Boston, President Dowell of Harvard spoke; at Chicago, President Judson of the University of Chicago, and at San Francisco, President Wilbur of Leland Stanford, Jr., University.

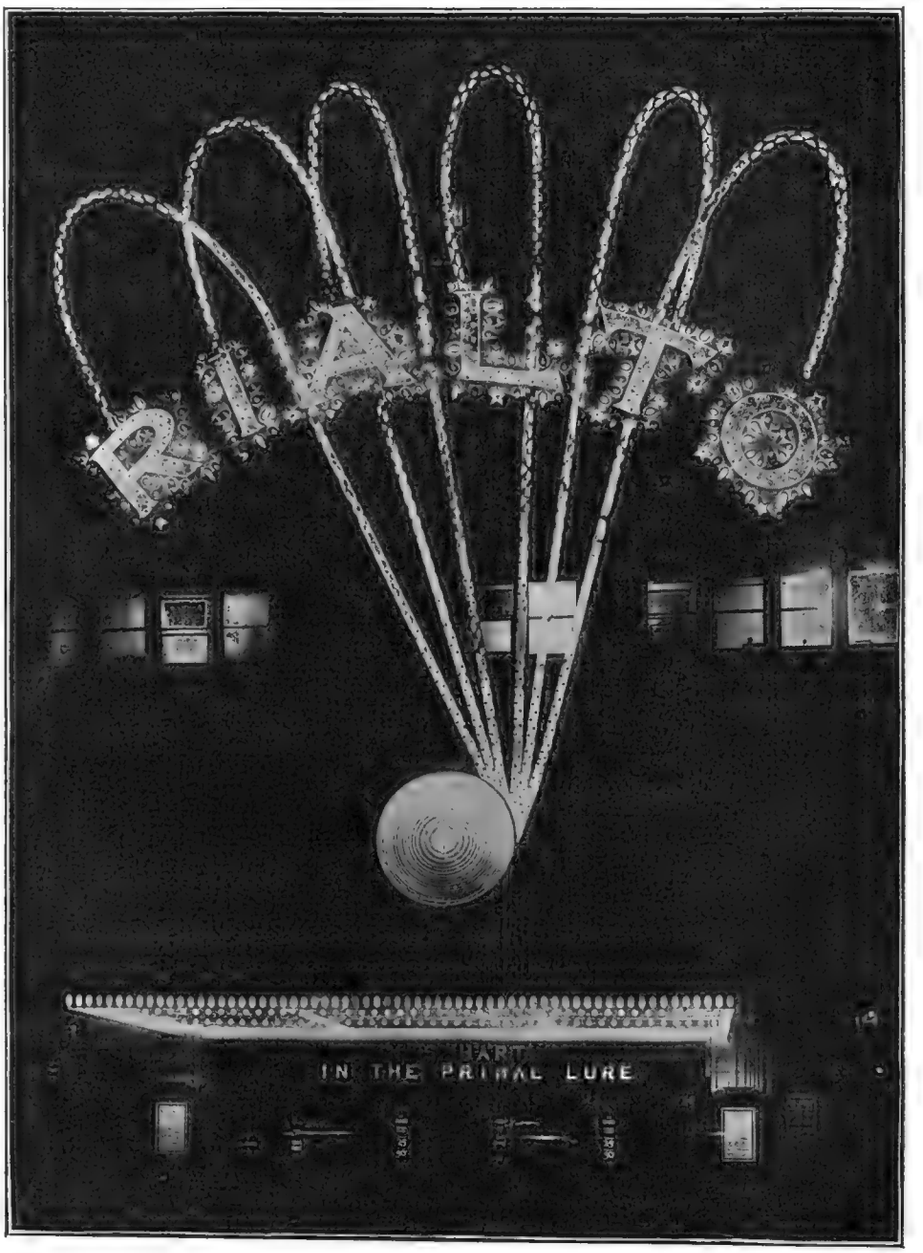
Officers of the American Institute of Electrical Engineers for the ensuing year were chosen as follows: President, Harold W. Buck; vice-presidents, L. T. Robinson, Peter Juckersfeld and B. A. Behrend; treasurer, George A. Hamilton, and secretary, F. L. Hutchinson.

A Monster Sign With Electric Skyrockets

One of the latest, most interesting and unique electric signs in New York City is that at Seventh Avenue and Forty-second Street. This magnificent sign measures fifty-six feet in length and fifty-two feet in height. It contains five series of vari-colored lamps, and a total of 6,000 bulbs. The operation is extremely interesting. The pinwheel located at the bottom has a large number of colored lamps which are placed in concentric ring form, while the whole mass is rapidly revolved by means of a motor and gear. The various loops are illuminated separately and rise from the pinwheel, until they reach their particular letter, when the latter is lighted. As each streamer shoots upward, the hissing sound of a skyrocket is produced by compressed air.

This process is followed throughout the complete loops until finally every one of the letters is lighted as in the photograph. The various shaped figures which encircle the different letters flash continuously. After all the letters have been lighted the rockets again ascend, but this time the whole sign is lighted in another color. The lighting system is controlled by a specially designed flasher operated by an electric motor.

This photograph was taken in a rather interesting manner. Since all the lights are not on at the same time, it was quite a problem to know how to show all the lamps lighted. Finally arrangements were made to set up the camera in an office opposite the sign. Very short exposures were made during different stages until every light had been photographed while it was lighted. The time required to take the picture was over two hours, but a much finer view of it was made than if only part of the lights had been shown. *Photo courtesy Mr. Adwell of the Rialto Theater.*



Spectacular Electric Sign Now on Exhibition in New York City. The Skyrockets Rise Upward One By One, Until All of the Letters Are Illuminated. This Action Repeats Itself in Several Colors and a Hiss Accompanies Each Rocket Ascension.

Novel Electric Typewriter

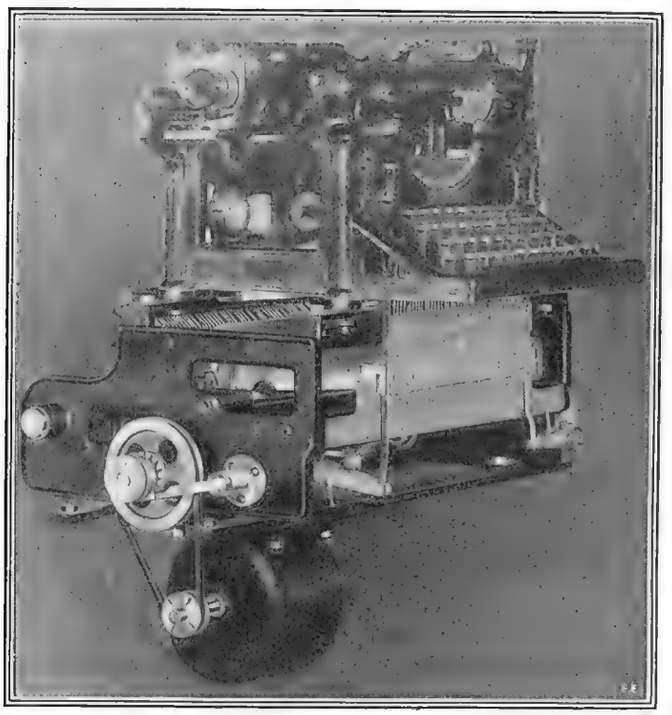
Modern business methods frown upon our present printed or facsimile "typewritten" letters. Most people can easily tell a printed letter from one actually typewritten, the former therefore usually remains unread and goes at once into the waste basket.

An electrically operated typewriter is the latest acquisition to business efficiency. It is operated by a perforated record of whatever text is to be produced and this is prepared on a small machine called a perforator. This machine has a keyboard corresponding in layout to the keyboard of the typewriter. The record paper has a double row of holes along the two edges; these holes are for feeding and guiding the paper both in the perforator and on the Automatic. A roll of paper is placed on the perforator and passed through a slot directly under the punches to which the key levers are connected and then over onto the feed drum; this drum has pins around each end and these pins project through the marginal holes of the record paper and guide and feed the paper as stated above.

Then the operator begins with the letter which is to be produced, pressing down each key lever in spelling out the words, exactly the same as if writing the letter on a regular typewriter. At the end of the line, instead of returning the carriage as on the typewriter, another key marked "Carriage Return" is pressed and this produces a hole in the record which will cause the typewriter carriage to return. The operator goes on with the next line and repeats until the letter is finished.

If at any place in the letter it is required to insert some personal matter, such as a name, a line, or a portion of a line, all that is necessary is to press down the key marked "Motor Control" and the machine will stop at this place.

At the end of the letter the operator punches the stop hole so the Automatic will stop at this place The record is now finished so it is cut off and the two ends pasted together, making an endless strip, so that when the end of the letter is arrived at, the beginning is ready to start off.



By Passing a Previously Prepared Paper Stencil Thru This Rapid-fire Electric Typewriter, Exact Multiple Copies of Your Letter May Be Obtained at a Prodigious Rate. Manual Keyboard Also Operative.

The record is then placed on the Automatic typewriter here illustrated and set at the start of record. This is done by placing it on the drum so that the pins of this drum match the marginal perforations of the record paper and all holes will then register properly. For instance, where the "A" hole is, this will operate the "A" lever and so on with each character or operation.

The Automatic drum has grooves running the full length from end to end and the holes on the record come directly over these slots; directly over this drum there are the ends of fifty levers, in the end of each is a small pin which rests on the record paper and rides thereon when the drum is revolving. As soon as a hole comes under this pin in the lever the pin drops through the hole into the slot in the drum and as the drum is revolving the lever is pushed lengthwise forward, just in time for a moving part, called the rocker bar, to become engaged and tip up the end carrying the pin. This removes the pin from the slot and at the time this end is tipped up the other end is pulled down and as this latter end is connected by means of a hanger to the key levers of the typewriter, this type bar is tripped, causing it to print upon the letter. In turn each character is reproduced, and the letter is written exactly as the record or stencil is made. If any mistakes are made in cutting the record this will show on the letter but may be easily corrected by the attendant.

At the end of the line the carriage is returned by means of a mechanism on the side of the Automatic; this is put into action by one of the levers carrying a pin the same as a character lever.

The machine goes on writing until a stop or "Motor Control" hole comes along, when the machine will automatically stop. This stop can take place at any desired point; for instance, in the body of a letter a name, a sentence, a line, or even a whole paragraph can be inserted by the operator using the keys of the typewriter and then pressing the motor control button, when the machine will start where it left off and finish the letter, stopping at the end as usual.

The operator then removes the finished letter, inserts another letterhead, puts on the date, address and salutation, and presses the motor control button. The machine then does the rest, producing an *actual typewritten letter* in large quantities.

The machine writes from one hundred to one hundred and twenty words per minute and is said to do the work of five regular typewriters.

THE MOTOGRAPH ELECTRIC SIGN.

The motograph is the most recent development in electric sign construction. The display portion of the sign upon which the letters appear is studded thickly with sockets at regular intervals. Wires are carried from each socket to a terminal board on the controlling apparatus. By passing a perforated paper ribbon between this terminal board and a corresponding brush board, which is also a portion of he controlling apparatus, lamps corresponding to the perforations in the ribbon are aused to light up on the face of the sign.

Attractive Chicago Electric Sign Which Flashes Any Number of Advertisements Before the Public. After Each Advertisement the Time Is Given as the Lower Photo Shows.

The effect of the moving ribbon passing through the control apparatus is to cause the letters to appear at the right hand end of the display sign and to pass across its face and disappear at the left hand end. By this means a constantly changing reading can be caused to pass across the face of the sign in letters of huge size. To change the reading it is necessary only to perforate and install a new ribbon.

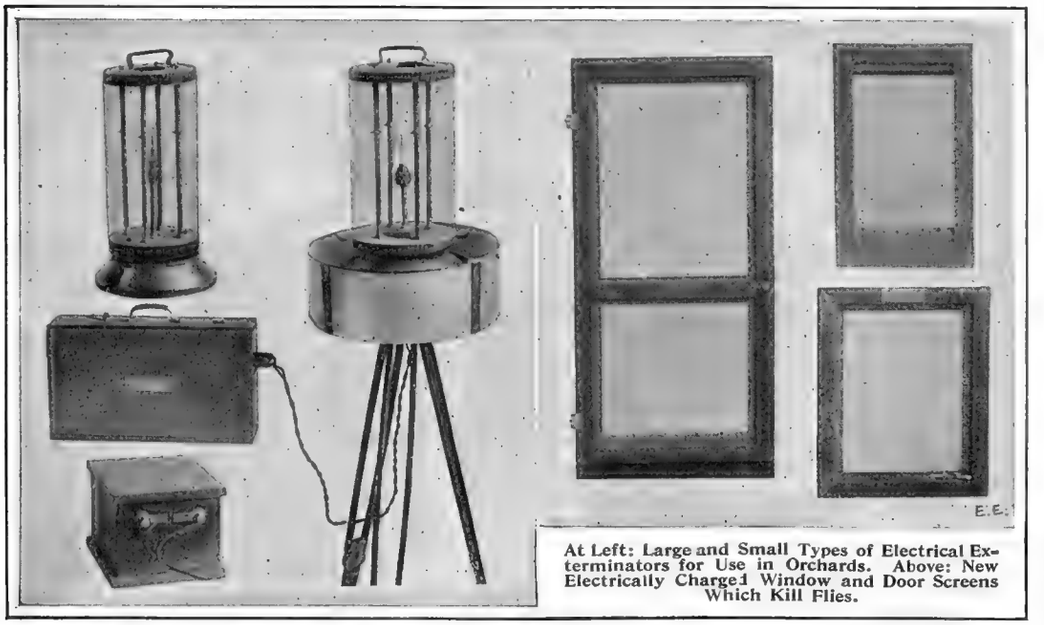
The largest motograph sign and at the same time one of the largest electric signs in the world is located at Michigan Avenue and Randolph Street, Chicago. The sign, which fronts south down Michigan Avenue, is 50 by 130 feet. The motograph portion turns the corner on Michigan Avenue so as to be seen coming down Randolph Street from the West. The motograph letters, 12 feet in height, move across its face in a space of about four seconds. The entire sign contains approximately 10,000 Mazda lamps.

In addition to the moving letter device, a clock mechanism is operated in connection with it. At the end of each advertising message the time is flashed upon the face of the sign and the words "YE TOWN CLOCK" appear above the motograph proper, the words "AMERICA'S LEADERS" going out when the time comes on and coming back when the time goes off, which it does as the next reading starts. This sign is seen by about 200,000 people daily, and upon clear nights the letters can be read distinctly as far south as Twenty-second Street. The clock feature is greatly appreciated by the thousands regularly passing and keeps their interest in the sign alive. Photo courtesy of the Federal Sign System (Electric).

New Electric Summer Comforts

UNUSUAL ELECTRIC SCREENS AND INSECT DESTROYERS.

The accompanying illustrations show a very useful and novel assortment of electrical window and door screens, also several specially designed electrical devices intended to kill insects of all kinds. The screens consist of areas of wire screen or grids specially designed to carry a sufficient charge of electricity to instantly kill flies, mosquitoes, gnats and other small insects attempting to alight upon or pass through them, and constitute one of the most practical methods of insect extermination yet devised.



At Left: Large and Small Types of Electrical Exterminators for Use in Orchards. Above: New Electrically Charged Window and Door Screens Which Kill Flies.

The screens or cylinders are connected with a high-voltage transformer, mounted in a neat case, so as not to be obtrusive, besides being readily portable. The larger outfit consists of a transformer, case, tripod and wire-wound cylinder, with an electric lamp attractor for use during the nighttime. This is intended for use in gardens, orchards, fields and plantations. The smaller cylindrical insect destroyer pictured in the upper left-hand corner is intended particularly for the extermination of moths. It is extremely efficient when used in orchards for destroying the Codling moths.

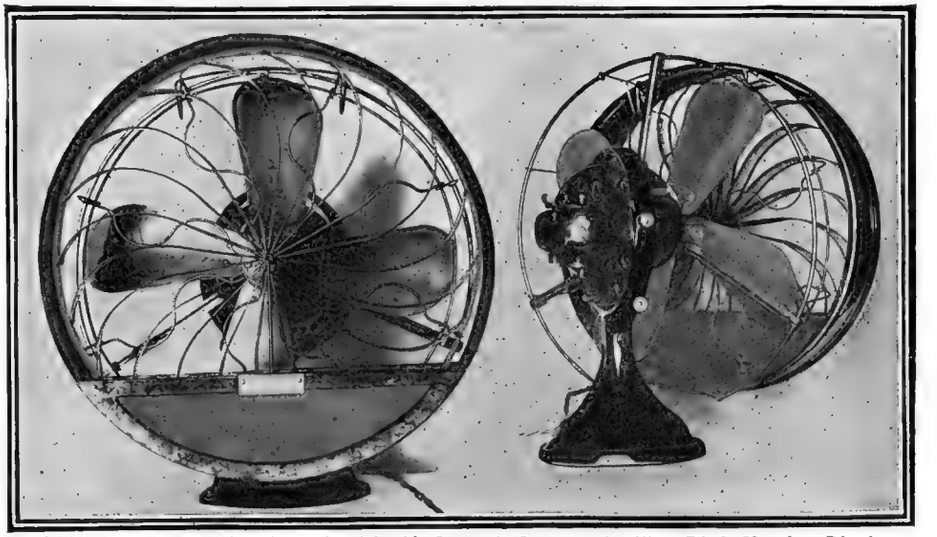
The electric insect-destroying wire-screens and doors have alternately charged wires, that is, adjacent wires are of opposite polarity; thus, when an insect makes connection across any two wires with its feet or wings, there is a circuit formed, and the current supplied is sufficiently powerful to instantly kill it. However, the electric charge is carefully proportioned so that it will not prove dangerous to human life. Moreover, the amount of current required for maintaining a constant charge on this apparatus is remarkably small.

Where electric light current is not available, these devices may be successfully operated from wet or storage batteries. Any six-volt battery of the latter type will suffice. In one instance, a four-cell battery charged one hundred square feet of screen for ten hours each day, six months, without requiring recharging or any other attention. In using the orchard type of moth exterminators, where they are subject to frequent moving, the storage battery works very well indeed, supplying current for lighting the lamp within the cylinder, as well as charging the wires.

AN ELECTRIC FAN THAT COOLS AND PURIFIES THE AIR.

A remarkable new electric fan has recently been patented and is illustrated herewith. This fan removes 99 per cent. of dust or bacteria from the air it is said. It transforms a bedroom into a sleeping porch, furnishes a supply of pure and humidified air every hour, and eliminates the dangers of poorly ventilated theatres, restaurants, churches and lodging rooms. The 16-inch fan handles an air volume of about 2,600 cubic feet per minute. When in action but a few minutes, it will never allow a temperature above 65 degrees, although the temperature of the room may be 115 degrees.

Several of these fans have been used in the Pickwick Theatre, San Diego, Cal., with excellent success. An auxiliary set of wire net blades in the attachment are caused to revolve by the air draft set up by the regular fan blade. It washes and purifies the air, as well as cooling it. The auxiliary blades of the fan run through a tank of water which vaporizes into the air. If hot water is put into the tank, in a few minutes after the fan is started it will become ice cold. This fan cooling and purifying attachment is known as the "Zero," and is adaptable to any size fan. It is particularly efficacious in hot countries, and moreover, when desirable, a perfume or disinfectant can be added to the water in the tank, which will be evaporated by degrees by virtue of the revolving blade creating a powerful draft of air. This acts upon the constantly wetted blades and thus also the humidity is improved.



An Electric Fan That Really Cools. The Air Currents Cause an Auxiliary Blade Member, Dipping in Water, to Revolve Also. The Water or Disinfectant Is Evaporated From These Blades.

ELECTRIC SHOE DRYER.

It is a hard task to polish tan shoes because of the fact that it requires so long to dry the leather after the cleaning fluid has been applied. A number of the largest shoeshining parlors in the cities have recently installed electric shoe dryers to overcome this difficulty. Whereas this work of drying the leather was formerly done by fanning the shoes with a palm leaf, or a folded newspaper, it is now accomplished easily and quickly with electricity. The dryer is arranged so that a blast of air, heated by electricity, is directed upon the wet leather, drying it very quickly and in a very satisfactory manner.

FANS HELP IN KITCHEN.

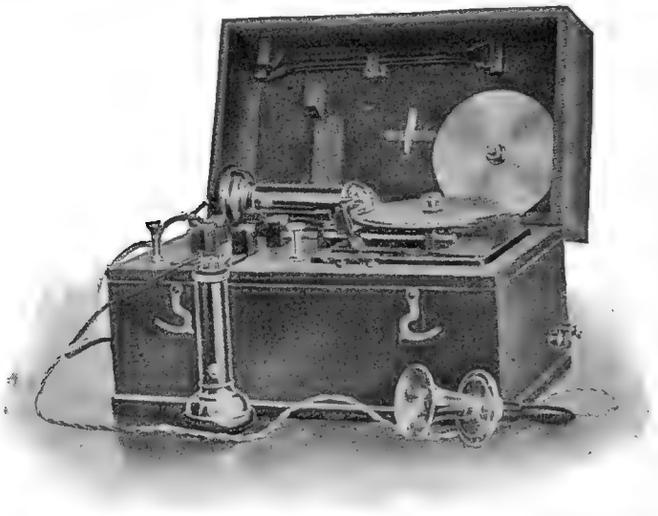
One of the most useful applications of an electric motor about the household is the small motor driven exhaust fan for the kitchen. Everyone appreciates the need of a ventilating system for the kitchen.

Without a ventilator the odors from cooking will penetrate the entire house and linger in the rooms long after the meal itself is gone. The motor driven exhaust fan consists, as the name suggests, of a small motor attached to a powerful fan. The device is mounted in an upper pane of a window, near the range and well toward the top of the room.

Electric pumps are used to irrigate 3,000 acres of rice in California.

A New Telegraphone Dictating Machine for Business Offices

The standard pattern of telegraphone as developed by Poulsen, the Danish inventor and scientist, is undoubtedly familiar to most people. One of the latest instruments of this type, particularly adapted to various business requirements, such as for dictating purposes, recording telephone messages in the absence of the subscriber, etc., is illustrated here. This type of telegraphone employs a thin iron disc, similar in appearance to the records used on the Victrola phonograph. These discs are very thin and light, as may be judged from the second illustration. They can, when recorded with a message, be readily mailed in an envelope, so that the person receiving them can place the discs on a transcribing machine and hear the message in the telephone receiver attached to the apparatus, or the stenographer can typewrite the reproduced speech.



Latest Type of Poulsen Telegraphone for Office Dictation Purposes. Utilizes Flat Steel Discs on Which to Record Speech Instead of Steel-Wire.

Regarding the operation of this remarkable speech-recording mechanism, it may be said that it represents one of the greatest inventions of all times. In contradistinction to the wax cylinder or composition disc type of talking machine, in which the record is renewed by shaving, the Poulsen discs are renewed almost instantaneously, as far as recording a new message on the iron disc is concerned. To remove the speech-record on the disc, or on the wire in the older type telegraphone, it is only necessary to reverse the direction of the disc or wire, allowing it to pass under the influence of a powerful magnet, which creates a change in the molecular structure of the iron member. This restores the molecules of iron to their neutral positions. They are then ready once more to be coerced into a definite magnetic state by the recording magnet of the machine. This can be repeated as often as desired.

In speaking into the apparatus, a microphone controls the electric circuit through the recording magnet. The small magnet passes over the iron disc in much the same manner as the reproducer on the well-known Victrola.

Once the speech has been thus recorded on the iron plate it will not weaken appreciably for a long time. In reproducing this magnetically recorded speech the disc is rotated under a small magnetic coil, and the fluctuations created in this coil cause changes in the currents flowing through the circuit to which a telephone receiver is connected.

Great promise is held forth for the adoption of the telegraphone for the purpose of handling business and personal correspondence, and it has proven in many instances particularly efficacious in recording telephone speech, either for detective work or for commercial requirements. The remarkable feature about the telegraphone is that the iron recording element may be used over and over again which is not the case with any other form of talking machine.

The Latest Telegraphone "Dictation" in the Form of Thin Steel Discs May be Mailed; the Recipient Transcribing the Speech Record on His Machine.

CAPTAIN BULLARD TALKS ON WIRELESS.

Captain W. H. G. Bullard, U. S. Navy, Superintendent of the Government Wireless Service, with headquarters at the Arlington Station, recently addressed Section 4 of the American Electric Railway Association. Captain Bullard described the progress made by the Government in its wireless system.

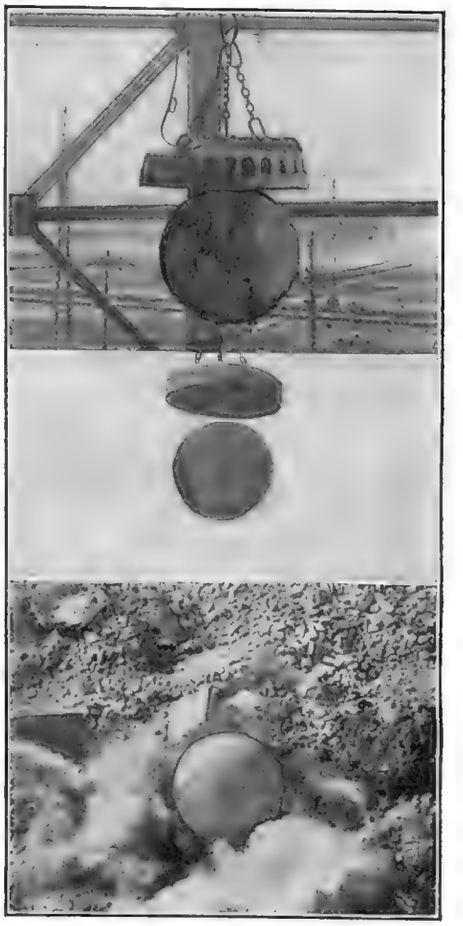
By means of a receiving set of instruments installed in the building a reproduction was made of messages sent out from the Arlington station, and the time signal and Weather Bureau signals were heard by all in the room. Captain Bullard said that this branch of the Government service offered special opportunities to general wireless operators.

"MOVIES" SHOW POWERFUL MAGNET IN ACTION.

It is not often that we see pictures of objects in the act of falling through space. The accompanying views show the performance of a powerful 62-inch lifting magnet in operation at the works of the Indiana Steel Company, Indiana Harbor, Ind.

The magnet is here employed to hold a 20,000-lb. steel ball, known as a *skull-cracker*. It is used for breaking up steel and iron castings which are to be remelted. This massive weight is dropped through a distance of fifty feet. When the magnet and the attached ball reach this altitude, the current is switched off and the ball falls to the earth, striking the casting with such force as to throw small pieces over one hundred feet.

The three views show respectively: the heavy duty lifting magnet holding the skull-cracker ball; the ball starting on its downward journey, and last the appearance of the ball at the moment of impact with the iron castings.



The "Movies" Have Here Pictured a Massive 62 Inch Electro-Magnet in the Act of Holding and Releasing a 20,000 lb. Steel "Skull-Cracker" Ball. The Lower Photo Shows the Ball at the Moment of Impact with the Iron Castings.

Besides being used for testing the strength of materials, this method is extensively used to break up imperfect castings, so that they may be remelted in the blast furnace. *Photos, courtesy of Cutler-Hammer Clutch Company.*

COAL MINES TO USE WIRELESS.

Wireless telegraph service to connect the Harlan coal field, in the Kentucky mountains. with the outside world is planned. The wireless service may be extended generally through Kentucky mountains, where difficulties of establishing wire lines are considerable indeed.

ELECTRIC INCUBATORS AND EGG TESTERS

Although electricity has been utilized in practically every conceivable field of human endeavor, it is finding new and fruitful applications in hatching and brooding chickens and also for testing eggs.

The great advantages of the electric incubators over the others are that they are simple to operate, the temperature can be closely controlled, which is a very important factor in operating these devices, ventilation is perfect, no smoke, fumes, soot, or odors are present and there is absolute safety from fire.

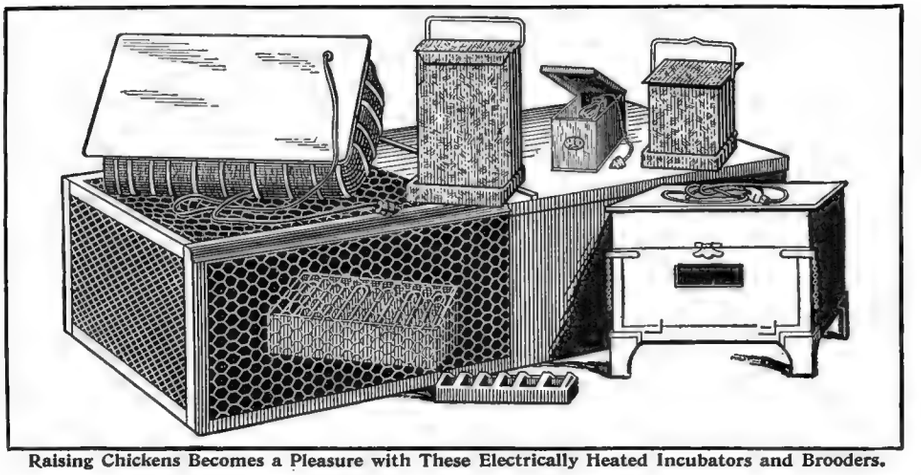
The accompanying illustration shows a complete outfit which consists of an electric incubator, brooder, egg tester, and several other devices necessary for such work. The incubator shown on the right is of metal construction and the outside is heavily coated with enamel. The egg chamber is made of galvanized iron. The ventilation is controlled from the outside by a metal slide in the bottom of the incubator. The humidity tank is mounted on a flange attached to the side of the egg chamber. The electric wiring is placed between the outer and inner metal parts of the removable top lid of the machine, so that nothing is exposed except the socket for the bulbs and the circuit-breaker.

The temperature of the incubator is automatically controlled by a thermostat, which regulates the heat required in the incubator to a nicety When the temperature rises a quarter degree above the point for which the thermostat was set, the circuit is automatically broken and the current is shut off from the lamps. As soon as the temperature falls, the circuit-breaker immediately is put in action and again lights the lamps. This thermostatic breaker is placed on the cover of the incubator.

The egg trays are of heavy galvanized wire and are so made that they will hold 100 eggs. The door of the machine is equipped with double glass windows so that the interior can always be seen. A card slide is attached to the side of the machine for keeping records of the hatch.

The electric egg tester is of metal construction and is equipped with a reflector and incandescent electric bulb. This device is especially well adapted for use in eliminating non-fertile eggs from a prospective hatch. It may also be used as an egg-candling box.

Electricity has at last saved the farmers the danger and trouble accruing from the use of old-fashioned oil, gas and gasoline incubators.



Raising Chickens Becomes a Pleasure with These Electrically Heated Incubators and Brooders.

STEINMETZ 51 YEARS OLD.

Dr. Charles P. Steinmetz passed his fifty-first birthday on the ninth of last April. He was born on Palm Sunday, April 9, 1865, in Breslau, the capital of the province of Silesia, Germany. He came to America in 1889. He had left Germany and gone to Switzerland about a year earlier, a political refugee from Germany, where the police were seeking his arrest on account of his Socialistic activities.

He landed in New York June first, on a French liner, having come over in the steerage with a young man who had studied with him in a Swiss university. He had some difficulty in being admitted at Ellis Island, as he had little money and "no visible means of support." He is now chief consulting engineer of the General Electric Company, and was formerly professor of electro physics in Union University.

Brooklyn Tries Articulated Trolley Cars

While we have had for a number of years articulated locomotives, it has remained for the Brooklyn (N.Y.) Rapid Transit Company to bring out an articulated trolley car. Its appearance is observed in the accompanying illustration. In this manner two small cars may be combined so as to serve the purpose of a single large car, and besides make the sharp curves in the track more effectively.

In the particular design illustrated the entrance of the articulated car is at the center and also practically on a street level, or a few inches above it, a great boon to the fair devotees of the hobble skirt.

The design of these trolleys was based upon the fact that more rolling stock had to be provided, and the engineers of the B.R.T. Company evolved this scheme, which permits the utilization of the old style shorter cars.

In building the new double type car the old units are extensively renovated and reinforced. One platform is entirely removed from each of the single truck cars to provide for the suspension of the new center section. This section is sustained on a swivel bolster attached to the end and side sills of each section. This results in a car completely closed at the center and to carry this out more thoroughly the end platforms are completely vestibuled. Folding doors are provided on one side for the use of the motorman and for exit purposes. The entrance and exit for passengers are in the center section, provided for by means of two sliding doors pneumatically operated by a mechanically controlled valve. This section is also equipped with a fare box and register of the electric, motor-driven type. These cars are provided with buzzers and push buttons on the side posts for the use of passengers in signaling the motorman, besides heating equipment provided with a thermostat and magnetically operated switches.

Brooklyn, N. Y., Is Trying Out a Boston Idea, That of Making a Large Trolley Car from Two Small Ones. The Street Level Entrance Is at the Centre, Where the Conductor Is Also Located.

FOREST RANGERS TO CARRY PHONES.

A portable telephone, made of aluminum and weighing two pounds and a half, the invention of a forest officer, B. B. Adams, of Missoula, Mont., will be part of the regular equipment of patrolmen on the national forests during the coming field season.

It is said a field man equipped with this telephone, a few yards of light emergency wire and a short piece of heavy wire to make the ground connection can cut in anywhere along the more than 20,000 miles of forest service telephone lines and get in touch with the headquarters of a supervisor or district ranger. Contact with the line wire is made possible by removal of the insulation from the emergency wire.

MARCONI COMPANY TO INSURE ITS EMPLOYES.

The Marconi Wireless Telegraph Company of America announces that the company has decided to maintain for all employes, without expense to them, insurance amounting to $500 for all those who have been with the company more than one year, and $1,000 for all employes who have been in the employ of the company five years or more.

The Gyroscope—Its Great Utility

By E. J. Christie, M. Sc.

THE gyroscope completely stabilizes the Brennan mono-rail car and the two-wheeled automobile. The gyroscope greatly reduces the rolling of ships on the ocean; it gives almost perfect safety to the aeroplane, and further, it stabilizes and guides submarine and automobile torpedoes.

The universally mounted gyroscope always points to the North pole and is used as a mariner's compass on our iron-clad battleships and submarines.

Another marvelous use of the gyroscope is found in the unicycle shown in Fig. 1. This unicycle is twenty inches high, weighs 60 pounds and is driven by an electric motor of ⅕ H.P. It runs entirely upon the one central rim, while the two side rims never touch the floor except when the machine is at rest. The two gyroscopic flywheels on the main axle are driven by the electric motor at a speed of 3,000 revolutions per minute. They so completely stabilize the unicycle that it cannot upset and, moreover, it is utterly impossible for it to "skid and turn turtle." The electric motor is swung below, and attached to the main axle by ball bearings. The electric motor receives current through two slip rings and a pair of brushes, Fig. 1. The gyros revolve steadily so long as the motor is operated. An idler pulley, actuated by a lever, allows the traction belt to be tightened as desired. A belt from the motor to a fixed pulley on the main axle swings the motor *forward and upward,* in the arc of a circle, and thus propels the unicycle forward.

This motor-driven unicycle, running entirely on one rim, stabilized by two gyroscopic flywheels so that it is impossible for it to upset, is surely a very unique idea.

The perfect performance of this little unicycle is more surprising when you remember that the machine weighs but 60 pounds and operates perfectly with only ⅕ H.P., or an exact relative ratio of 300 pounds to 1 H.P.

The little gyroscope shown in Fig 2, may be used by any experimenter to prove and demonstrate the perfect stability of this unicycle. Give it a swift kick sideways and see it slide over the floor, but still retain its vertical position. Again, loop a string around pivot "A" or around pivot "B," and by means of this string quickly lift this gyroscope into the air vertically. The gyroscope retains its vertical position, does not upset, but precesses (revolves) around the string.

Can we perform the same experiment with the large unicycle, containing its engine and driver, shown in Fig. 3?

Let us build this large unicycle, Fig. 3, with only one rim, 14 feet in diameter; equip it with a Heath 300 H.P. gasoline motor weighing 550 pounds and suspend the motor on a frame 5 feet below the main axle of the unicycle. Let us utilize 5 H.P. to spin the gyroscopic flywheels, leaving the remaining 295 H.P. entirely for the propulsion of the unicycle in the forward direction. Question—How fast can this unicycle travel on an automobile speedway? Can we solve this problem? Let us start with the definition of the H.P.

Definition: "One horsepower is the equivalent of lifting a weight of 33,000 pounds through a vertical distance of 1 foot in 1 minute."

Solution: When this definition of a H.P. is applied to the above problem, where the engine lifts its own weight of 550 pounds *forward and upward* through an angle of 90 degrees to the forward or horizontal position, the definition then takes on the form of the following equation:

$$\text{H.P.} = \frac{\text{Weight} \times \text{Rev. per Min.} \times \text{Circum.}}{33{,}000}$$

Then, substituting the above values, we have the following equation:

$$295 = \frac{550 \times \text{R.P.M.} \times 31.416}{33{,}000}$$

or Revolutions per Minute equals 563. But 120 R.P.M. of this unicycle, 14 feet in diameter, covers one mile per minute. Then 563 R.P.M. will cover 4.69 miles per minute, with absolute certainty (theoretically).

But, in all probability, the total resistance to the forward speed of this unicycle will force the engine *forward and upward through an angle far less* than 90 degrees. Then we have 4.69 divided by the sine of the actual angle, and we get some of the enormous speeds shown in the following table:

Angle 90 degrees, speed 4.69 miles per minute.

Angle 60 degrees, speed 5.4 miles per minute.

Angle 50 degrees, speed 6.1 miles per minute.

Angle 40 degrees, speed 7.2 miles per minute.

Angle 30 degrees, speed 9.3 miles per minute.

In all probability the speeds will lie somewhere between these two extremes, depending largely on track conditions. More suitable and more powerful high-speed engines can be used to further increase the possibilities of the unicycle racer.

The front cover illustration is of a pleasure type of unicycle which would seem to possess many worthy characteristics. If such a model as this is provided with a hollow rimmed outer wheel it can negotiate such paths as that afforded by a single rope stretched across a canyon or valley. The unicycle of commercial proportions may be 50 to 60 feet high or more and sufficiently narrow to pass along ordinary streets. The details of such a machine as that in question are given in the sectional drawing, Fig. 4. Here there is proposed a swinging carriage which, in its closed cab, carries a powerful gasoline or internal combustion engine such as the Diesel type. Direct connected at either side of this engine are two 3-phase alternating current generators which supply current to the two gyro wheel motors on either side of the center axis. At the center of this *son-of-a-gyro-cruiser, a la Lyon,* is a powerful propelling motor. Its stator windings are fastened to the outer frame-work casting and the whole frame, including the "cab" suspension girders, arranged to swing backward or forward freely.

The motor windings are made to revolve the gyroscopic flywheels. These gyros, even while rotating at high speed, may be

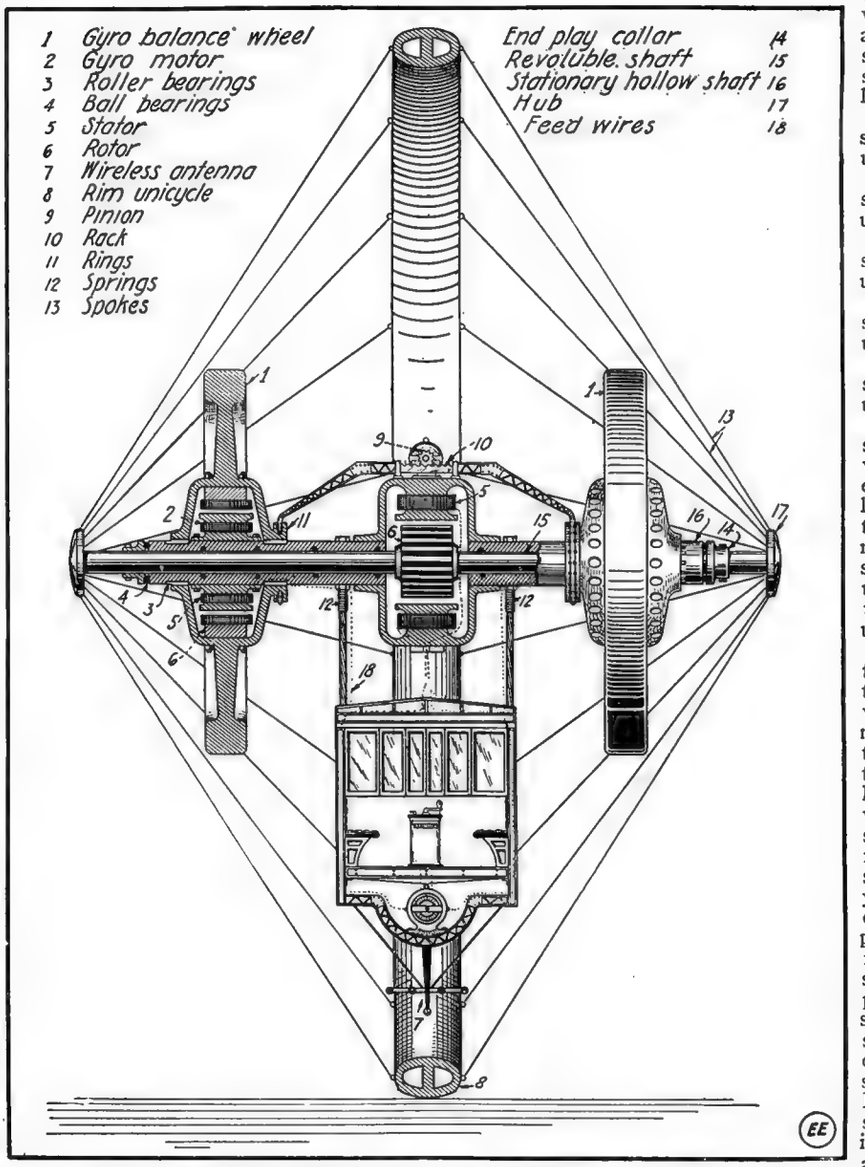


Fig. 4. A Giant Unicycle Land Flyer Utilizing Two Powerful Motor-Driven Gyroscopes to Maintain Its Equilibrium. The Unicycle Propelling Motor is Mounted Directly on the Shaft of the Outer Travelling Wheel.

moved simultaneously to right or left by a steering control motor mounted on top of the propelling motor. The steering motor works through a pinion and rack teeth provided on the transverse girder. The latter carries at either end a ring journal which travels between two lines of ball bearings, as the drawing indicates, to minimize friction or stiffness of motion as much as possible. With both revolving gyros equally balanced with respect to the center of gravity of the unicycle, the traction effort will be straight ahead or rearward, depending upon the initial direction of rotation given to the propelling motor. A slight shifting of the gyro-control lever, effected by an electrical control of the steering motor, will cause the unicycle to turn one way or the other, depending upon which way the gyros are shifted, i.e., to the right or to the left. It is possible to attain the same results by the simple shifting of a balance weight suspended pivotally on the center axis line of the unicycle.

With such a tractor it is not beyond the range of possibilities to reach a speed of locomotion exceeding 3 to 4 miles a minute. Unless one has actually tried the experiments cited with a miniature gyroscope it is hard to conceive of the truly remarkable and peculiar qualities involved in its action when the gyros are turning at high speed. This unique machine will maintain an upright position without wobbling just as soon as the gyros are sufficiently accelerated. It turns corners with the unicycle structure perfectly vertical, not bent over, and as a matter of fact the turning or precessional power exerted by simply shifting the gyros to right or left is several-fold that gained or ever made possible by having the vehicle *lean in.*

When the unicycle starts along its path the suspended car swings back, then forward and upward, thus augmenting the velocity of the vehicle. In stopping it a brake applied causes the car to swing to the rear half of the unicycle wheel. Moreover, simply the weight of the engine in the front half of the unicycle forces it to roll forward, and again, shifting the weight of the engine in the rear half of the unicycle gradually retards and stops the forward movement.

The enormous speeds possible with the unicycle should certainly cause it to appeal to the speed-loving public. It would certainly be interesting to see one of these going along a street.

The shifting of the gyroscopes and their

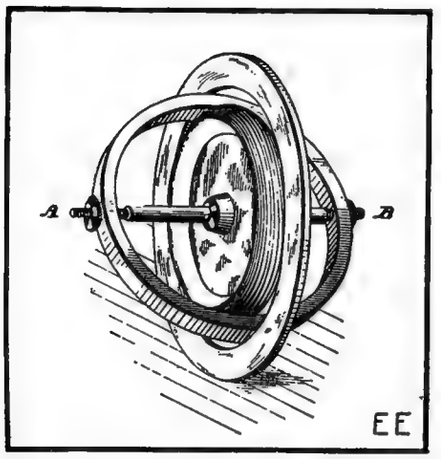


Fig. 2. A Toy Gyroscope with Which All the Marvelous Properties of Such a Device May Be Easily Demonstrated.

great precessional powers are more than sufficient for guiding and steering the unicycle at any and all times. The steering-post, in the hands of the driver, is used for shifting the gyroscopes.

Naturally, we ask, what will be the future of this marvelous invention?

Will it go into general use on the public highway?

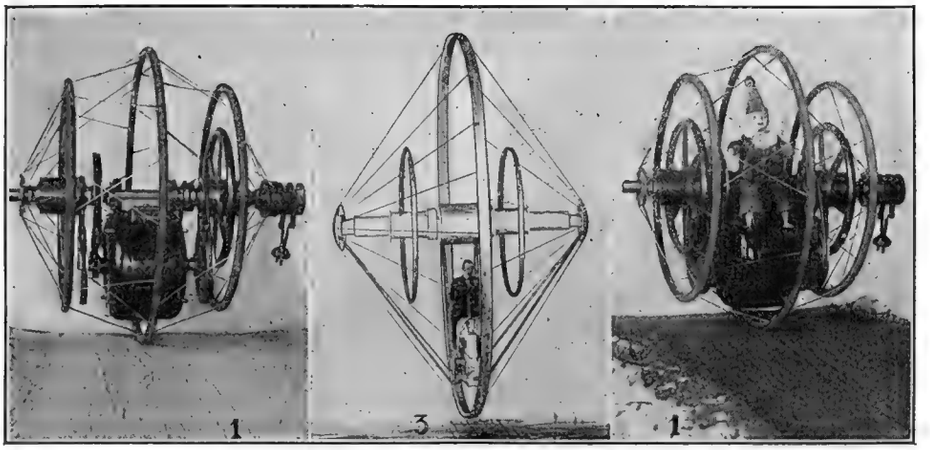


Fig. 1, Shows a Small Motor-Driven Unicycle with Double Gyroscope Built by Mr. Christie. Fig. 3 Is a Proposed Large Size Unicycle Equipped with Gasoline Engine Motive Power.

Since this unicycle can use a concave rim and run on a single rail or wire cable, will it go into fast mail service?

With a single-rail, air-line from New York to 'Frisco how long would it take to cross this continent?

GRAVITATION AND ELECTRICAL ACTION.

In former publications the present writer has suggested that there is an intimate relation between gravitation and electrical action at a distance, or what has been called statical effects, says Francis E. Nipher in *Science*. There can be no doubt of the statement that the attraction between two masses of matter depends not only upon the amount of matter in the two masses, and their distance from each other, but also upon their electrical potential.

The gravitation constant has been determined by finding the attraction between two spheres of metal. In these determinations the electrical potential of the masses has been ignored. It has been assumed that there are no electrical charges on the two masses, if their potential is that of the earth.

Assume that two spheres having radii R_1 and R_2, composed of metal having a density ρ, and distant from each other r, have charges Q_1, and Q_2, the spheres having a common potential V. Their attraction for each other will be

$$A = K\frac{m_1 m_2}{r^2} - \frac{Q_1 Q_2}{r^2}$$

$$= K\frac{16}{9}\frac{\pi^2 R_1^3 R_2^3 \rho^2}{r^2} - \frac{R_1 R_2}{r^2}V^2$$

Here K is the value of Newton's constant of gravitation, as it would be determined by the method of Cavendish or Boys, if V were zero absolute.

If V is not zero, and the second term is omitted, the last equation might be written

$$A = K\left(1 - \frac{x}{100}\right)\frac{16}{9}\frac{\pi^2 R_1^3 R_2^3 \rho^2}{r^2}$$

In this equation K (1—X/100) is the gravitation constant that would be determined under such conditions. Both K and x would remain unknown quantities.

Equating these two values of A

$$V = \tfrac{4}{3}\pi R_1 R_2 \rho\frac{\sqrt{Kx}}{10}$$

If V is measured in volts

$$V = 40\pi R_1 R_2 \rho\sqrt{Kx}$$

If $R_1 = 10$, $R_2 = 1$, $\rho = 11.35$ and $K = 6.6576\times10^{-8}$

$$V = 3.68\sqrt{x}$$

This result shows that if these two spheres have a common potential which differs from absolute zero by 3.68 volts, the value of K as determined by the Cavendish method will be in error by one per cent. of the above value which is that of Boys. If V were ± 8.23 volts, an error of five per cent. would result. If V were 36.8 volts the two spheres would cease to attract each other. The absolute zero in V would be the common potential of the two bodies, when their attraction for each other is a maximum.

Storm clouds and the electrified atmosphere are continually acting inductively upon the earth's surface. The potential difference at the ends of a flash of lightning may amount to thousands of millions of volts. Aside from such disturbances, we are wholly in the dark concerning the average potential of the earth.

It is evident that the smaller the masses used in such determinations, the greater will be the possibility of error in the result, when the potential term is ignored.

It seems very probable that we do not know the real value of the gravitation constant.

PRACTISE THESE WORDS IN YOUR SPARE MOMENTS

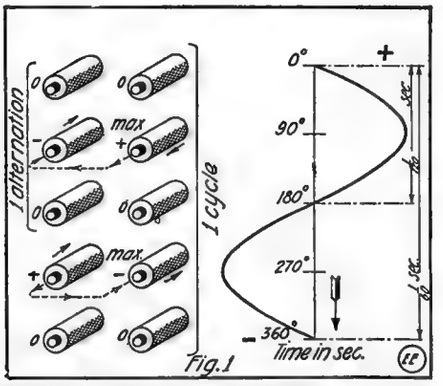
Some of the newest words invented by chemists to describe new substances are cited by the *Medical Record* as illustrative of the barbarous terminology that they are trying to foist upon us. Among these are the following, all taken from a single number of the *Journal* of the Chemical Society: tetradimethylaminotetraphenylhydrazine, dimethylaminophenylmethyoquionediimide and tetramethyldiaminotetramethyldiaminodiphenyldihydrophenazine. These the editor of the *Medical Record* calls "Gargantuan philological outrages."

ELECTRIC RESTAURANT FOR MINE.

A large Western mining company has installed an electric restaurant 150 yards in from the foot of the shaft in one of its mines. Here food is cooked or heated electrically, and hot coffee is prepared by the same means. Since most of the important coal mines already use electric power underground for power purposes, there should be little difficulty in establishing subterranean electric restaurants in any of them.

The Difference Between Alternating and Direct Current

The average reader who may not have any particular education in purely electrical matters invariably becomes stumped



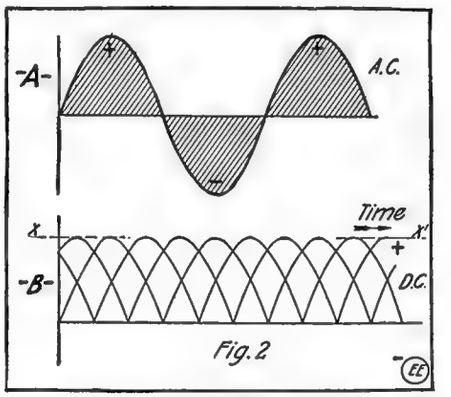
How the Current Reverses Periodically in an A. C.

when asked the difference between an alternating and direct current, so a few words on this important subject may not be amiss.

By referring to Fig. 1 and considering that the two sections of wire there shown are the two conductors of, say, an ordinary lighting circuit, then the changes taking place in the electrical activity existing in them will become more evident with the aid of the following explanation: To begin with, it may be said that if direct current passed through these conductors one of them would be positively charged, while the other would be negatively charged, and this state of affairs would exist continuously as long as the circuit carried any current.

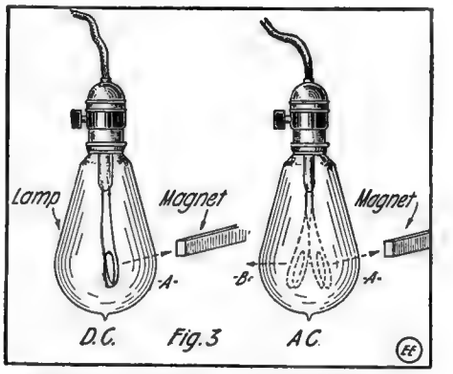
If an alternating current dynamo were connected up to the circuit, then at a certain instant the current would be at zero potential in both conductors. This current then would gradually rise to a maximum value at a point 90° from the starting point, as shown in the time curve depicted at the right of Fig. 1. This point is also known as one-quarter of the cycle or one-half of the alternation, there being two alternations to one cycle. Again the current in the conductor opposite the point 180° of the time curve, as you will see, has reached the zero point of electrical activity once more. From this point on the current now increases in strength, but in the opposite direction or in a negative sense, as shown by the dotted lines between the two conductors. The maximum negative value is reached 270° from the starting point of the time curve, and from there decreases until it reaches 360°, or the completion point of the *one cycle* and zero of activity. The process is repeated over and over again at the rate of 60 times per second in an ordinary lighting circuit. Therefore there will be 7,200 *alternations* every minute, or 3,600 *cycles*. The current reverses so rapidly at this rate that no appreciable flickering in an incandescent lamp is noticeable. However, when the frequency drops below 40 cycles a flickering due to the constant reversal changes in the value of the current becomes very marked and objectionable.

The difference between direct and alternating current is graphically shown in Fig. 2, by means of the time curves there plotted. At A the positive and negative curves (half waves) or alternations of the current are perceived. From this it can be seen that a single wire of an alternating circuit can never be called the positive or negative wire, as each wire becomes positively and negatively charged alternately many times each second. The direct-current dynamo, owing to the commutator effect involved in the production of the current, gives a multiple wave form somewhat like that shown at B, Fig. 2. No ordinary direct-current dynamo fitted with commutator and brushes can yield a pure direct current such as that given by batteries. This latter current would have the wave form, corresponding to a straight line, marked X-X'. In many scientific and other experiments, therefore,



Graphic Representation of Alternating and Direct Current.

it is practically imperative that a storage or other form of battery be utilized. This was the case particularly with the audion detector now well known in the radio field, but in latter-day practise the pulsating nature of the direct current has been overcome by the use of a potentiometer of special construction and other means. Capacity and inductance will smooth out such ripples in a wave.



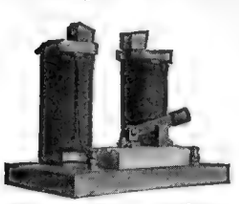
Simple Test for Direct and Alternating Current.

A simple test which may be performed by anyone without in any way subjecting himself to a shock, to determine whether a line is carrying a direct or alternating current, may be conducted in the manner outlined at Fig. 3. This scheme involves the use of the electro-magnetic field produced in the filament of an ordinary carbon incandescent lamp. In this lamp the filament generally coils around one or more times, so that an appreciable electro-magnetic field is thus produced. Now, if a permanent steel magnet of the bar or horseshoe type be brought close to the lamp two distinct actions will take place, depending upon whether the lamp is connected to an *alternating* or *direct current* circuit. If it is a *direct current*, the filament will be either attracted or repelled according to the polarity of the pole nearest the lamp. If it is an *alternating current* passing through the filament, the latter will vibrate, owing to the ever-changing polarity of the field of magnetic force produced by the filament. If a pencil be waved back and forth in front of an incandescent bulb then an exact outline of it may be perceived throughout its movement when direct current is used. If alternating current supplies the lamp, a blurred outline only will be perceived owing to the constant changes in the light intensity.

When in the neighborhod of alternating current machinery there is generally an appreciable hum noticeable, which is invariably lacking in the case of direct current machinery. This is due to the constantly changing magnetic polarities in the laminated iron structure of A.C. machinery.

A MAGNETO REMAGNETIZING DEVICE.

A particularly efficient and economical remagnetizing device is shown in the accompanying illustration. It may be operated from any 6 or 12 volt storage battery or also from dry cells if desired. It consists of two powerful electro-magnets mounted in an upright position on a wooden base. A switch and two binding posts are mounted on this base. The device is fitted with special pole-pieces which are interchangeable for the purpose of charging Ford magnetos without removing them from the automobile. This device is very handy in every way as it weighs but 8 pounds ind measures 7 inches by 4½ inches by 5¼ inches.



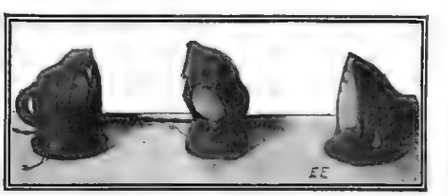
Magneto Remagnetizer.

ELECTRIC LAMPS TELL WEATHER.

A progressive drug firm in Louisville, Ky., has hit upon a weather forecast as an advertising feature. On a shield shaped sign placed outside the door, the company's name and the word "Drugs" are set out in bold relief by twelve-inch lamp studded letters. Below the sign, arranged in three columns of two, are the words "Fair," "Rain," "Warmer," "Colder," "Wind," and "Snow."

NEW ELECTRIC POTTERY LAMPS.

Several unique designs, including that of a bird, are here shown in the form of some new electric portable lamps made from pottery. These lamps are very unusual in design and are particularly attractive for use in libraries, parlors, boudoirs, etc. The designs are furnished in a number of different colors and are in line with the latest effects desirable in modern interior decoration schemes. Those shown are comparatively small, of course, but large size pottery lamps are made by these same manufacturers besides artistic electric fixtures in pottery.



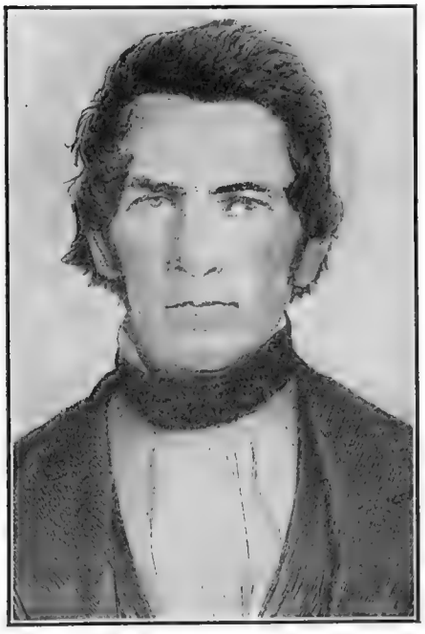
Attractive Electric Table Lamps in Pottery.

THOMAS DAVENPORT.
July, 1916, Marks His 65th Death Anniversary.

Born, 1802—Died July 6, 1851.

THOMAS DAVENPORT was born in Williamstown, New Hampshire, in 1802, and his untimely death occurred at the age of forty-nine years. Davenport's father died when he was barely ten years old, and at the age of fourteen he was apprenticed to the blacksmith trade at Forestdale, three miles from Brandon, Vermont. The boy's education was very meager, but one day he chanced upon a few excerpts from a scientific work, treating with the electro magnet of Henry, and soon after this he secured a magnet and made a battery of his own.

In one corner of the little blacksmith shop Davenport set up a bench for his laboratory. Here he began his first experiments with electricity which were later to make his name famous throughout the world. From the first his struggles were pathetic and bitter. Poverty stood as a gigantic barrier between him and success and upon one occasion it was necessary for his young wife



Thomas Davenport, Inventor of First Successful Electric Railway.

to sacrifice her silk wedding dress to supply insulating material for a motor which he attempted to build. It was a heaven-born flash of insight which revealed to the young inventor the availability of power from an electro-magnetic source and although he had to work entirely with batteries, the generator being still undiscovered, his success in the field was truly wonderful.

It was in the corner of the old blacksmith shop that Davenport produced the first successful electric motor and even before Vermont had a mile of steam railroad, Davenport was successfully operating a model electric road which ran on a circular track, the embryo of the magnificent electric railways of to-day.

Davenport's miniature electric railway was almost a perfect model of the railway systems now in use. He advocated the central station methods of developing power, using the rails for the return circuit and the motor drive. But ill luck seemed to pursue the inventor to the very day of his death. From Vermont he moved to New York to be nearer the financial centers, for he sorely needed money to carry out his experiments and inventions. Once all his models and apparatus were destroyed by fire, and at another time they were lost in a shipwreck. Davenport tried by every known method to raise money for his work. He gave exhibitions and lectured, and finally established the first electrical technical journal which was ever printed by electricity.

Broken in health and in dire poverty, he returned to his native State, where he died July 6, 1851. Living, he struggled against adversity. Dying, he had not a dollar to his name, and for many years his very name had been forgotten, while the entire world was enjoying the fruits of his months and years of toil and study. Today the name of this modest son of Vermont stands forth as one of the greatest inventors the world ever saw, although few people realize that he made possible the wonderful work now performed by electric motors, of which there are thousands in use daily.

New English Incandescent Arc Lamps

It is well known from the experiments of Sir J. J. Thomson, Dr. Fleming and others that the filament in an incandescent lamp gives off a strong negative discharge, and if an additional electrode sealed adjacent to the filament be charged to a positive potential, a current passes between the filament and this electrode.

An application of this principle has been applied to overcome the difficulties encountered in making an arc incandescent lamp.

The first attempts on these lines were made with a lamp suitable for an alternating-current circuit. This lamp consisted of two small globules of tungsten fixed at a definite distance apart. As a means of breaking down the resistance of the gas within the arc gap, a filament was mounted adjacent to the electrode; this filament, when made to glow brightly for a few seconds, acted as an ionizing agent and made the arc gap conducting.

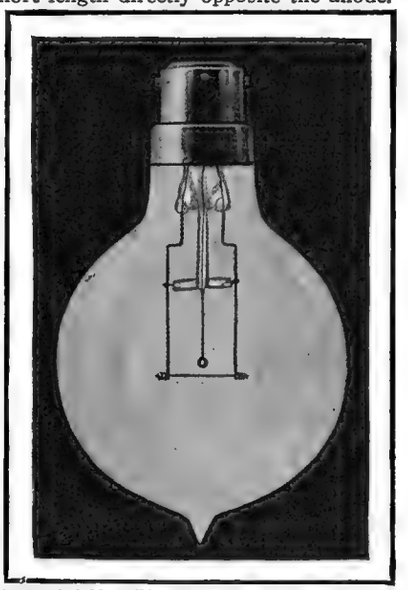
As used in the lamp, this ionizing circuit was connected in parallel with the arc circuit through an auxiliary single-pole switch and suitable resistance. On starting, the ionizing circuit was completed for a few seconds and then broken by means of the switch. This resulted in an arc being momentarily struck between one of the electrodes and the filament, this being followed by an arc between both electrodes, the filament acting as the ionizer being now entirely out of the circuit.

This lamp showed great improvement as regards both facility in striking and life.

Efforts were then directed to make a lamp for continuous-current circuits.

To try and obtain an ionizer which had a longer life than the tungsten filament used in the first lamp tried out a study was made of the action of other materials than tungsten as an ionizer. It is well known that several refractory oxides possess to a very high degree the property of emitting electrons; extensive experiments were therefore made with mixtures and combinations of tungsten with zirconia, yttria, thoria and other oxides of the refractory class.

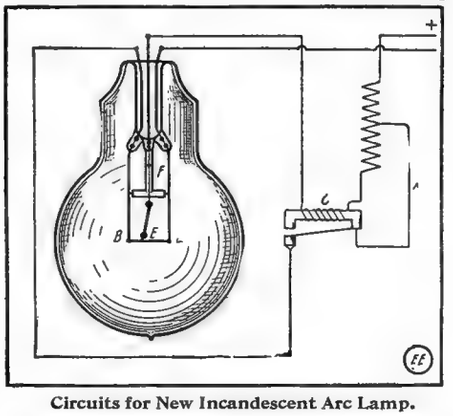
As a result of continued experiments, a satisfactory filament giving powerful ionization properties was evolved, it being found that if the filaments were carefully made they were not destroyed by the action of the arc and that they lasted considerably longer than a filament of pure tungsten. This was no doubt due to the difference in the physical state of the two filaments. However, difficulties still remained in the matter of restarting. The action of the arc after a time naturally destroyed the ionizing properties of the filament, and in some cases difficulty was experienced in restriking after two hundred hours' burning. This deterioration of the ionizing properties of the filament was only local, being merely around a short length directly opposite the anode.



Wonderful New Electric Lamp, in Which an Arc Occurs Between Metal Electrodes in an Evacuated Glass Bulb.

To overcome this objection, a short length of expansion strip was linked between the anode and its stem lead. A lamp constructed in this manner is connected as in the illustration which shows a lamp suitable for a continuous-current circuit. Three leads are led through the lamp stem; on one is mounted the electrode E, while the other two hold the filament, acting as an ionizer, B B′. The positive main lead is divided into two circuits, one of which, A, passes through a resistance and the contacts on the electro-magnetic switch C to one pole of the ionizer B, the other being taken through a resistance and the coil on the electro-magnetic switch to the positive electrode of the arc circuit E. The negative main lead is connected to the remaining ionizer lead B′.

In operation the current first passes through the ionizer circuit, causing the filament to incandesce at a temperature sufficient to ionize the gas between it and the positive electrode. At first a small current flows in the arc circuit. This current rapidly increases until the cut-out is operated. This breaks the ionizer circuit and the arc is "struck," the striking being assisted by the removal of the ionizer, which of course shunted the arc circuit. The heat rising



Circuits for New Incandescent Arc Lamp.

from the arc causes the expansion strip F to warp, and this moves the arc to another position on the ionizer.

(*Continued on page 206*)

The Electric Furnace

By Raymond Francis Yates

BUT a few years ago the electric furnace was a scientific curiosity. To-day it forms the basis of a great industry.

The origin of the electric furnace dates back to the time of Sir Humphrey Davy and his brilliant discovery of the electric arc, in 1810. As the arc forms the source of heat used in most of the furnaces of to-day, its discovery may be called the first step in the evolution.

Photo courtesy Snyder Electric Furnace Co.

750 K. W. Single Phase Electric Furnace. Single Electrode Type as Used in Production of Steel Elevator Castings.

As early as 1815 W. H. Pepys built a resistance type of furnace for converting iron into steel. He accomplished this by placing a cut in a piece of iron wire and filling the cut with diamond dust which is the purest form of carbon. He then passed a current through it till it became heated to redness. The iron absorbed the diamond dust and was converted into steel. Napier, in 1845, constructed a simple furnace which consisted of an arc "drawn" in a small crucible. He intended to use this to reduce metals from their ores. In 1849 Despretz built a resistance furnace. In this he used a small charcoal rod heated by the passage of a current from 600 Bunsen cells. Pichou described a furnace in the *Practical Mechanic's Journal* in 1853. This was heated by a series of arcs between large-sized electrodes. Although this furnace was never constructed, it was intended for the reduction of metals from their ores.

No marked progress was made until the invention of the dynamo. This replaced the expensive batteries and formed a much more reliable means of generating current.

Sir W. Siemens was the first man to produce a practical furnace, using the dynamo as the source of current. This furnace is shown in Fig. 1. It consisted of a graphite crucible B, and the lid F, provided with an opening through which to watch the operation. The metal was placed in the crucible and the arc established between the metal and the carbon electrode A. It is a well known fact that the positive electrode of an arc is raised to a greater temperature than the negative. For this reason the metal was made to form the positive pole. Siemens is also credited with the furnace shown in Fig. 2. The negative electrode B consisted of a copper tube closed at one end. Inside this tube was a smaller one through which water was introduced to keep it cool and thereby prevent the rapid consumption of the copper by the current. The positive electrode C was a hollow carbon rod through the center of which a reducing gas was injected.

In 1883 Faure invented a resistance furnace in which the heat was generated by the passage of a current through solid conducting rods imbedded in the bottom. This furnace was intended for the production of sodium.

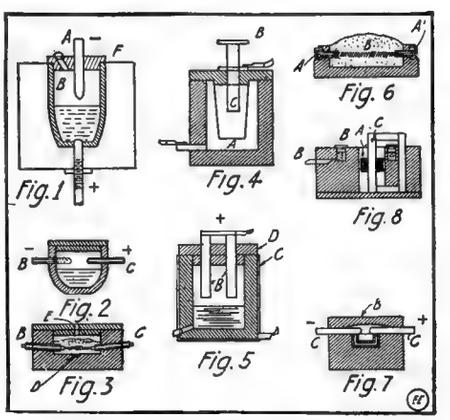
It remained for Messrs. Eugene H. and Alfred H. Cowles to make the resistance type of furnace a commercial success. Fig. 3 represents a drawing of this furnace. The rectangular firebrick retainer is equipped with two electrodes, B and C. The space between the electrodes is filled with small pieces of carbon which are raised to a very high temperature upon the passage of the heavy current that is sent through them. The charge, when melted, collects at D. The gas generated by this operation escapes and burns at the opening E.

Thomas L. Wilson founded a commercial process for the production of calcium carbide in 1888. This furnace, as it is actually employed to-day, is shown in Fig. 4. The charge is placed in the solid carbon crucible A. The arc is produced between the charge and the electrode C. The arcing distance is regulated by the handle B. The charge, when melted, collects at the bottom of the crucible. The Union Carbide Company of Niagara Falls uses this furnace and at present supplies the United States with practically all the carbide required. In its plant there are seventy-two furnaces which yield an output of 100 tons every twenty-four hours.

Mr. Charles Hall invented a method of producing aluminum electro-chemically in 1886. This process is now controlled and worked by the Aluminum Company of America, who operate several large factories at Niagara Falls. A general view of the Hall furnace is shown in Fig. 5. The furnace in its present form is provided with four electrodes in place of the two shown in the drawing at B. The electrolyte which forms the negative pole is contained in a rectangular iron tank lined with a heavy coating of carbon. An outlet is provided at the bottom.

Dr. Edward Goodrich Acheson has recorded his name in the history of the electric furnace by his processes for the manufacture of carborundum and artificial graphite. The furnace in which the production of these articles is accomplished has become commonly known as the "Acheson Furnace" and is shown in Fig. 6. Although it is an extremely simple affair, it is very efficient. The long firebrick trough is equipped with two large graphite electrodes, AA¹. The charge, B, fills the space between the electrodes and forms a high resistance conducting path for the heavy current used. The sides of the furnace are of a temporary nature, being composed of large fire bricks that are built up and taken down at the end of each "run." The Acheson Graphite Company of Niagara Falls have succeeded, with the aid of this furnace, in obtaining a graphitic carbon reaching a purity of 99.98%.

The name of Henri Moissan has become known to the world through his brilliant high temperature researches and a number of processes owe their origin to his ingenuity. One of his most notable experiments is probably that of constructing artificial diamonds. An almost exact reproduction of the Moissan furnace is now in use in the laboratory of the Paris University and is shown schematically in Fig. 7. The body is made up of two limestone blocks, one of which serves as a cover. At the great temperature which the arc produces between the electrodes CC limestone would melt and vaporize. To prevent this, alternate layers of carbon and magnesia are used to form the crucible. The highest temperature (7,232° Fahr.) ever reached, has been produced in this furnace. Carbon, the most refractory substance known, has been converted into graphite and volatilized.



Various Types of Electric Furnaces.

The induction furnace has become recognized as a practical invention through the efforts of Colby, Ferranti, Rochling-Rodenhauser and Kjellin. The furnaces of these inventors are all based on the same principle and a description of one will suffice for all.

(*Continued on page 205*)

Some Popular Misconceptions of Magnetism

WHILE some of the more ordinary rules governing the effects and dangers of electric currents are quite well known to most people, it is often amusing and indeed astonishing to note the quite remarkable ideas that are often entertained in regard to magnetism. In the first place, a great many people believe that magnetism may be insulated and otherwise controlled in the same manner as the electric current, which we may state before going further is not the case at all. There is no insulator of magnetism and no metal or other substance so far found by our chemists and scientists that has manifested any greater efficiency in screening or reducing the effect of magnetism than does plain air.

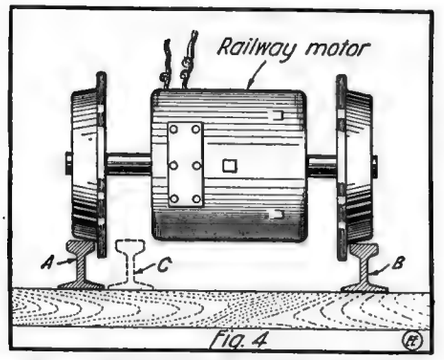


Fig. 4. Magnetic Relation of Electric Train Motor and Steel Rails; C Represents Guard Rail.

Simply because a substance such as brass, which happens to be non-magnetic, is available is no reason that it will cut off or protect any body from the effects of magnetism. Brass, as a matter of fact, has no more effect in this direction than air itself.

One of the commonest troubles experienced from magnetism, and possibly one of the least understood by the layman, is that occurring when his watch begins to lose or gain time at a prodigious rate. The *magnetized* watch is generally a nuisance to its owner and everyone else until it has been *demagnetized*. Two simple methods extensively used for demagnetizing watches are indicated at Fig. 1. The scheme at A consists of suspending the watch on a string held in the hand, and the next requisite is a fairly strong steel horseshoe magnet. The magnet should be laid on the table and the watch is held about a yard away. The watch should then be spun so that it will rotate rapidly at the end of the string. While spinning in this fashion it is approached to the poles of the magnet and then drawn away again. This is repeated several times, but great care must be taken in order that the watch shall not stop rotating while it is close to the magnet.

A second scheme and one adopted by jewelers and watchmakers is indicated at Fig. 1B, and it employs a small electromagnetic coil wound on a fibre or other non-magnetic frame, as perceived. Alternating current from a lamp socket or other source of supply is passed through the coil and the magnetized watch can then be inserted in the center of the coil for a few moments. This will suffice to destroy any permanent magnetism existing in the steel parts of the watch movement.

The prevention of magnetization in watches has been a field often exploited more or less successfully, but at the present time there are very few non-magnetic watches in use, it seems. Some years ago there was devised what was called a magnetic watch protector, which consisted of a hinged soft iron shell, illustrated at Fig 2A. This is supposed to protect the watch from magnetization as long as the watch is kept in it. However, for those having to make use of a watch around electrical machinery, this method is, of course, utterly worthless, as the case would have to be opened and therefore a scheme which could be used very well is shown at Fig. 2B. This involves the use of a soft iron shell placed around the movement of the watch proper, and, of course, the front side of this iron shell is placed under the dial, so that no trouble is experienced in using the watch wherever and whenever desired, such as for testing electrical machinery, etc. A scheme said to work out very will in this direction is to have a phosphor bronze hairspring substituted in the watch in place of the usual steel hairspring.

Referring to Figure 3, there is depicted roughly some of the more strongly magnetized portions of dynamos and motors. In the case of small motors such as shown at A, there is generally a considerable magnetic force manifested at the ends of the shaft, and this locality should be watched, therefore, in respect to the use of stop watches and the like when testing the speed of the motor. There is also a small magnetic leakage around the iron yoke of the field frame, and if the machine is fairly well inclosed, with iron bearing support plates, there is a slight leakage all around, but not to any great extent.

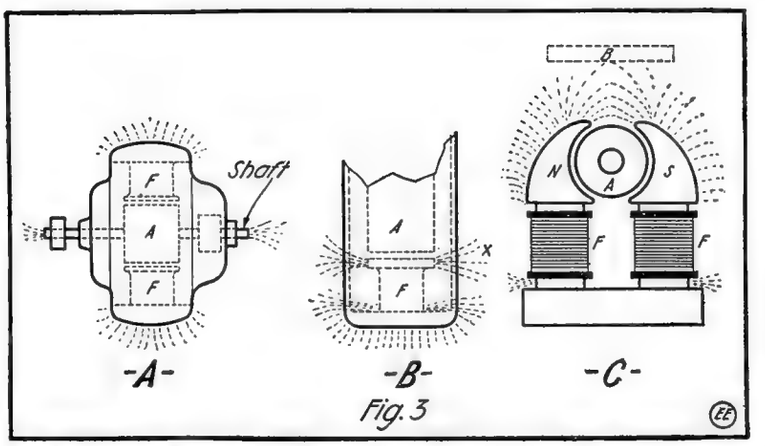


Fig. 3. Showing Magnetic Leakage or Stray Field about Dynamo and Motor Frames.

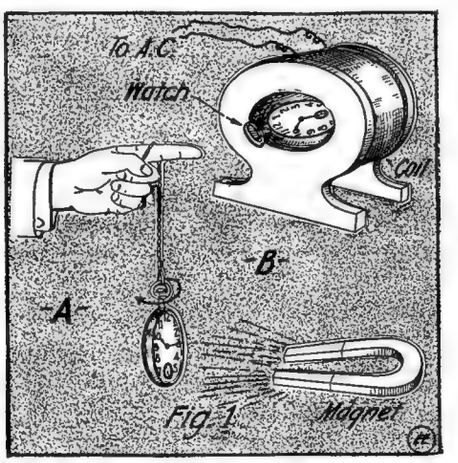


Fig. 1. Two Methods of Demagnetizing Watches.

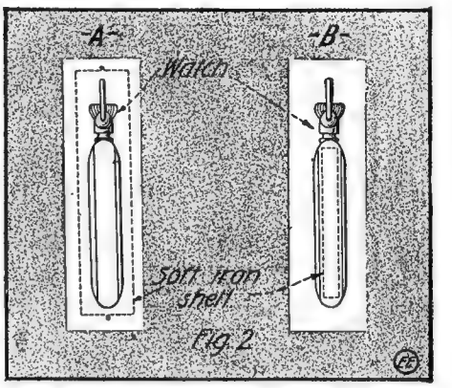


Fig. 2. Protecting Watches Against Magnetism by Iron Shields.

When in the neighborhood of large motors or generators, such as those in power stations, it is best to remove the watch from the pocket and leave it at some distance from the machine, as, owing to the construction of these larger generators, there is quite often a very powerful magnetic field existing about them, somewhat after the fashion outlined in Fig. 3 B at J. At Fig. 3 C is illustrated the powerful magnetic field existing about the field poles of an old type of dynamo and motor often encountered even nowadays, and it is at once seen that watches of the ordinary garden variety have no business to loiter around within several feet of such a machine, as they are liable to become completely paralyzed or nearly so. An interesting point might be mentioned here and which is not commonly known to experimenters and others. This is that the speed of such a machine as just mentioned can be controlled by an iron bar "B" placed at a greater or less distance from the pole pieces N and S of the machine. This scheme of armature speed control has been actually used in a commercial machine.

An interesting case comes to mind that occurred some years ago, in which instance a railroad wreck occurred on a high speed electrified line, and as the electrical system of the type used was not very well understood at that time, or for some other reason, there was some rather interesting testimony given in the court hearing as to the cause of the accident. An electrical expert testified that he thought it possible that the magnetic leakage from the railway motors mounted under the cars might possibly have attracted the rails and caused them in some way to become deranged or moved from their proper position. Referring to Fig. 4, this particular case is outlined diagrammatically, and also a third rail "C," which is in some cases run along inside of the regular rail or else in some cases the rail C is simply a guard rail.

(*Continued on page 206*)

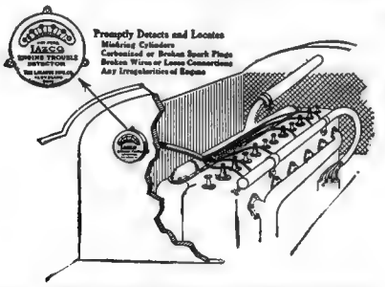
NEW SPARK PLUG TROUBLE DETECTOR FOR AUTOS.

The necessity for a device of this kind and its practical and essential value need hardly be elaborated upon with the present multiple cylinder engines. Engine trouble is bound to occur in all types and sizes of internal combustion engines and there is constant danger of trouble arising in high powered machines by reason of defective spark plugs, either carbonized or broken, loose or broken wire connections, ignition trouble in battery or magneto, loose or worn bearings and, in fact, any number of general causes.

Is it not a wonderful advantage when out in your car, should engine trouble develop, you can immediately tell from the dash without leaving your seat or raising the hood the exact location and nature of the defect?

The new spark plug trouble detector consists of a device enclosed in a nickel-plated case. The dial is 3 inches in diameter, with a case depth over all of but 1 inch, does not take up much room and, in fact, adds to the general attractiveness of the dash to which it is attached, or it can be carried in the car and attached when engine trouble develops.

The device comprises a dial face with a series of window openings in a circle, each consecutively numbered, corresponding with the number of cylinders. A glass disc is arranged inside and covers the open-


Prompdly Detects and Locates
Misfiring Cylinders
Carbonized or Broken Spark Plugs
Broken Wires or Loose Connections
Any Irregularities of Engine

The Latest Spark Plug Trouble Detector.

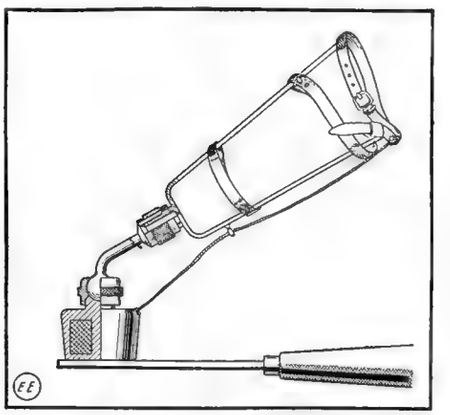
ings. Contacts are arranged within the detector to correspond with the various openings. Through the glass the driver is enabled to read the results ascertained by the indicator hand. A plurality of wires corresponding with the number of cylinders of the engine project through the back of the device and are attached to each of the cylinders. The interior mechanism is embedded in an insulating compound, making it absolutely impossible to get out of order. The current wires of the engine are not interfered with by the addition of the detector and the current follows its usual channels between the magneto, battery and spark plug; but when irregularities develop, by depressing a center button the current is carried to the detector and the indicating hand locates the trouble.

INVENTS AN ELECTRIC "HAND."

After years of experiment Director Klingenberg of the General Electric Co. of Berlin, Germany, has announced the perfection of an "electro-magnetic hand," with which it is possible to grasp even the heaviest metal objects and work with them as advantageously as with human hands.

Dr. Klingenberg has evolved an unusually powerful battery which can be carried by the operator, making it unnecessary for him to be near an electric current in order to magnetize the "hand." The invention, it is said, can perform all the functions of the human hand and others besides. The current is regulated by a switch operated by hand and foot.

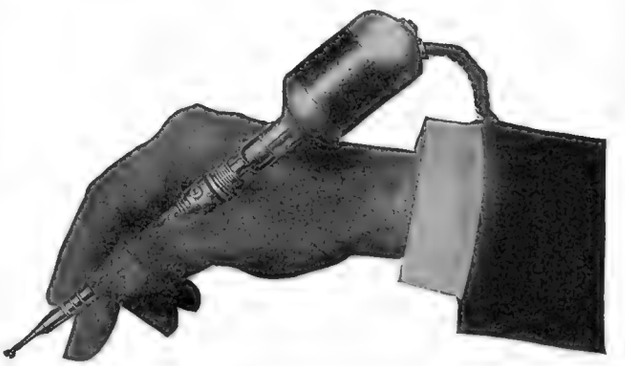
It is hoped the invention will solve the problem of livelihood for many crippled soldiers, enabling them to engage even in trades requiring considerable manual dexterity, such as carpentry. By its use the manipulation of knife and fork and similar instruments is a bagatelle.



A Magnetic Hand for European War Cripples.

THE SMALLEST DENTAL MOTOR.

One of the smallest electric motors ever constructed for practical requirements, most probably, is the one illustrated herewith. This forms a part of a new electric engine, as they are called in the dental profession.



This Motor, Built Like a Watch, Fits the Hand Comfortably.

The motors are built in the very best manner possible and supplied to operate either on alternating or direct current at any voltage from 6 to 250 volts. Thus the country dentist can have an electric engine for his drilling and grinding requirements, even though he has no electric service available from a central station, as the low-voltage motor will operate in an excellent manner from a storage battery, or dry cells may also be utilized. The storage battery in such a case would last from one to two weeks, depending upon how much the motor was used each day.

This engine is a direct-drive type and no reduction gearing is used. It is claimed that this arrangement represents the simplest, quietest and smoothest running device of its kind ever perfected.

The machine is so well built and designed that the whole apparatus may be sterilized readily, as no water can leak into the casing. It comes complete with a specially designed foot-controlled rheostat, which gives any desired speed at the motor by a light pressure of the foot against the controlling pedal. The tool chuck is removable and any standard form of drill or grinder can be attached in a few seconds to the device. It should prove a boon to the busy dentist who desires the latest and best motor that the market affords.

NEW SANITARY TELEPHONE MOUTHPIECE.

The telephone mouthpiece attachment here illustrated is a new, sanitary and very practical device for covering the transmitter, effectively keeping out all germs and foreign matter, thereby preventing the danger of spreading disease.

Most of us realize that while the mouthpiece of the telephone is an absolute necessity, it is an incubator of germs, a collector of filth, particles of food, tobacco, foul odors, etc., which eventually find their way back into the mouth of the next telephone user. This attachment makes the mouthpiece of the telephone absolutely sanitary and dust proof.

The attachment is made of steel, neatly finished, and fits securely over the ordinary telephone mouthpiece. It contains a small roll of sanitary paper, free from any objectionable odor, which by pulling from the bottom, can be changed as often as desired without any inconvenience to the user; each roll contains enough paper for about six months' use.

Sanitary Mouthpiece for Telephones.

FRENCH ACADEMY HONORS PUPIN.

At a dinner on Feb. 17 at the University Club of New York City, tendered by his professional associates and friends, Dr. M. I. Pupin, the distinguished electrical engineer and physicist, was officially notified by the Academie des Sciences de l' Institut de France, through Dr. C. O. Mailloux and Gano Dunn, of the award to him of the distinction of the Hebert prize for his "method of mathematical analysis of electrical circuits, which is to-day recognized as classical," and for his "discoveries and inventions in electrical resonance, the tuning of electrical circuits and the loading of telephone lines," which has come to be known as "pupinization."

U. S. CURRENT CONSUMPTION.

Last year, according to the census taker, the total output of the 5,521 central electric stations in this country was 14,000,000,000 kilowatt-hours of current.

New Tungsten-Molybdenum Alloy Substitute for Platinum

A DISCOVERY that is vastly more important than it seems on the surface was announced at a recent meeting of the American Institute of Mining Engineers in New York, by Dr. Frank Alfred Fahrenwald of the Case School of Applied Science, Cleveland, Ohio. This was nothing less than a substitute for platinum.

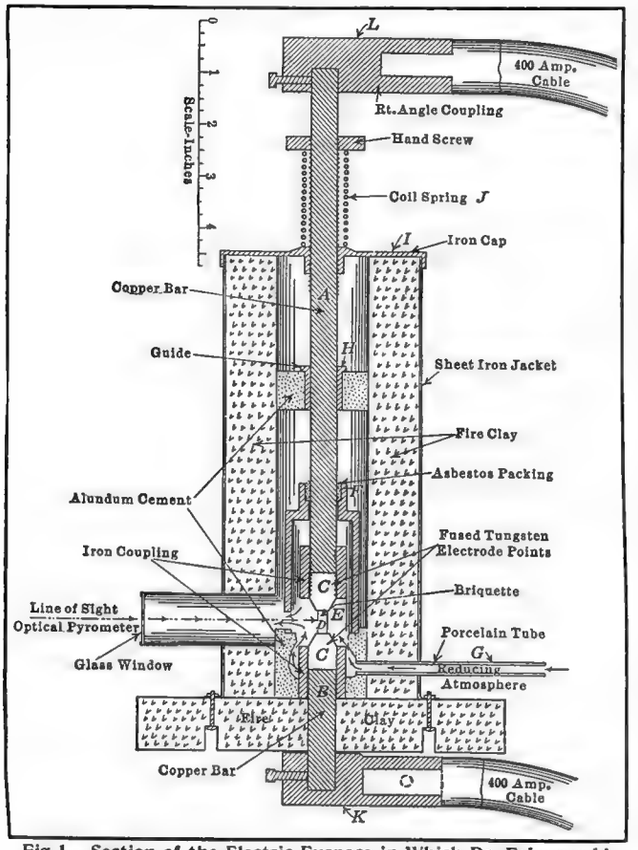


Fig 1.—Section of the Electric Furnace in Which Dr. Fahrenwald Forged Tungsten and Molybdenum at about 2,300 Degrees C., the Highest Temperature Ever Used in Metal Research Work. A and B, Electrode Bars with Fused Tungsten Points; D, Briquet; E, Heating Chamber; F, Sliding Cup; H and I, Guides; K and L, Electric Connections.

To appreciate fully how far-reaching is this discovery one has but to consider that platinum is now more than four times as costly as gold. It was quoted early in March at $88 an ounce, but if you tried to buy an ounce you would probably have to pay more than that. Platinum is so indispensable that the British Ministry of Munitions recently ordered a return of all

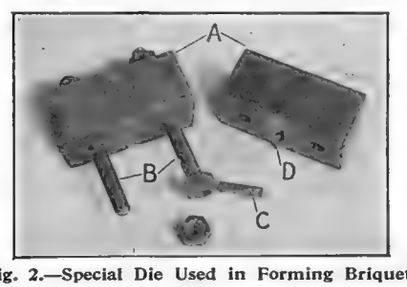


Fig. 2.—Special Die Used in Forming Briquet.

stocks of platinum, its ores and residues and forbade any trading in these.

Large quantities of platinum are used in jewelry, and until recently the wires passing through the thick glass neck of the bulbs of incandescent lamps were almost universally platinum, for the reason that no other known metal expanded and contracted as did glass. Platinum is used in many other kinds of electrical apparatus particularly for contact points. In metallurgy and chemistry it is invaluable for crucibles, because its melting point is 1,750 degrees centigrade, or almost 700 degrees higher than gold. It is unaffected by most acids, and is easily drawn into fine wire or thin foil.

A substitute for platinum has now been found in alloys of tungsten and molybdenum. These metals have, of course, long been known and used, but it has not hitherto been known how they could be made resistant to oxidation.

Dr. Fahrenwald conducted experiments that led to the solution of this problem. Tungsten and molybdenum possess many characteristics in common. The former melts at about 3,000 degrees C., the latter at 2,500 degrees C. They are practically insoluble in any of the common acids, their tensile strength exceeds that of steel, they can be drawn to finer threads than any other metals, while their specific gravity is 70 per cent. greater than lead. In recent years tungsten has been replacing platinum in the automobile industry. Their co-efficient of expansion is 50 per cent. lower than that of platinum.

The serious objections to them were that they oxidized easily at a red heat and that they would not readily solder with gold and its alloys. Moreover the larger wires were quite brittle.

The present investigator discovered that tungsten and molybdenum emerged from a bath of molten gold with a beautiful impervious coating. This removed the objection of corroding, but the metal was still as brittle as glass. Dr Fahrenwald then set to work to discover a way to overcome this.

It must be understood that all pure metals are aggregations of minute crystals. These crystals have not a regular geometrical shape, but have a definite and regular arrangement by which any metallurgist can recognize by a glance through the microscope with what metal he is dealing.

It might be thought that when a metal is broken it would crack along the interstices between the crystals, but it has been shown experimentally that the amorphous matter which, as it were, cements the crystals together, is the strongest part of the metal and that the break comes across the crystals themselves. From this it follows that the larger the crystals and the less of the amorphous matter, the more brittle will the metal be. There is naturally most of the amorphous matter in the metal with the smallest crystals.

Professor Fahrenwald tested at various temperatures and under various high pressures many combinations of tungsten, gold, molybdenum and palladium. He devised a special electric furnace that gave him 3,000 degrees C. temperature, of which a diagram is given herewith. The parts comprising this furnace (Fig. 1) consist essentially of two adjustable electrode bars, *A* and *B*, fitted with fused tungsten contact surfaces, *C*, between which the briquet *D*, is placed. Current is passed through the briquet which, by its own resistance and that between the contact surfaces, may be heated to any temperature up to its melting point. An inclosed heating chamber, *E*, is formed by dropping the sliding cup, *F*, into a close-fitting recess made for it at the base. Gas is passed through the tube *G* into this chamber, from which it escapes through the outlet shown. This opening serves also as a peep hole for an optical pyrometer.

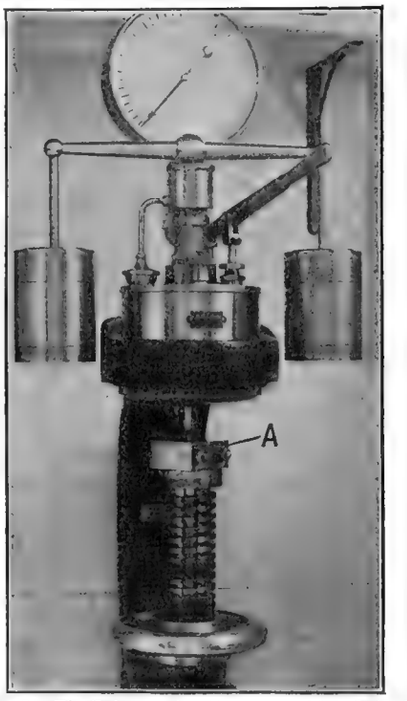


Fig. 3.—The Briquets Are Compressed in a Brinell Hardess Testing Machine to a Pressure of More Than 300,000 Lbs. Per Square Inch.

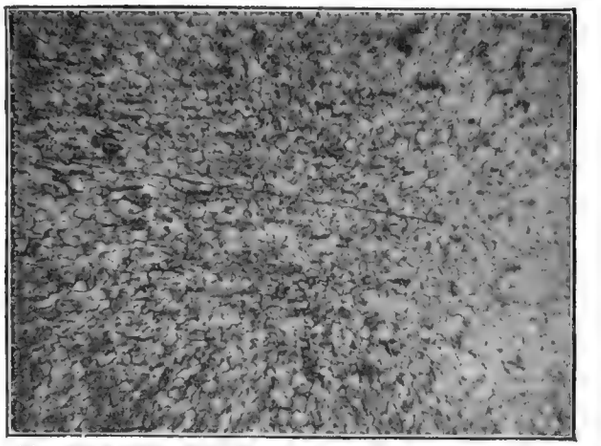


Fig. 4.—Micro-Section Photo of a 50 Per Cent. Tungsten-Molybdenum Alloy Briquet.

In operating, the bar, *A*, with its electrode and housing, *F*, is raised through its

(*Continued on page 205*)

Harnessing the Atmosphere's Nitrogen Electrically

By Samuel Cohen

THE enormous quantity of explosives used in the European war has caused a vast amount of experimental work to be carried out, in order to obtain "nitrates," which are the main chemicals involved in the manufacture of these explosives. At present all the nitrates are obtained from the Chilean nitrate beds, in its infancy while the saltpetre (sodium nitrate) of South America is still a formidable competitor of the artificial product. The new process consists of passing a discharge of between 3,000 and 5,000 volts pressure between two electrodes, a powerful electro-magnet being used as a deflector with its polar extremities at right angles to the direction of the discharge. The electrodes are placed one-half inch apart and the discharge is sufficient to ordinarily fuse the electrodes. To prevent this they are constructed so as to allow a steady stream of water to pass through them for cooling purposes.

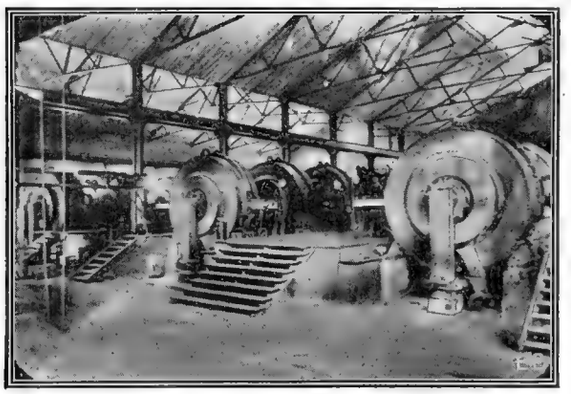


Fig. 3. The Birkeland-Eyde Electric Furnaces Used in Norway for the Reduction of Atmospheric Nitrogen into Sodium Nitrate and Other Commercial Commodities, a Process Soon to Be Exploited in This Country.

especially sodium nitrate ($NaNO_3$). This is being constantly and voraciously consumed, and at the present rate of consumption, it will not last a great while, hence it was imperative that research work should be started so as to find a method of making this compound artificially.

It is stated that in Germany a large number of plants have been built for producing this substance by obtaining nitrogen from the atmosphere. The method which the Germans employ is purely electrical. This scheme of harnessing the atmosphere's nitrogen is not new, however, as it has been under development for several years both in this country and Norway. However, as England has blocked Germany's route to Chile, so that she cannot obtain her nitrate supply from that country, the Teutons were forced to manufacture their much needed nitrates. Therefore plants for this work were created by the brain-work of some of the greatest chemists, of whom Germany has long been sponsor, as is well known.

Not only are the nitrates important in the manufacture of explosives, but they are also far more important as fertilizers.

The most interesting method of fixing the nitrogen of the atmosphere is one in which man copies the handiwork of nature. It is a well-known fact that thunderstorms are something more than rolls of thunder and blinding flashes of lightning, that the electric sparks produced in its path cause a "chemical reaction," which leaves oxides of nitrogen and traces of ozone in the air. The oxides are washed down into the earth by the rain and so contribute to some extent to a renewal of those nitrogen compounds so necessary for the betterment of soil and crops. It is many years since Sir William Crookes demonstrated the burning of air by means of a high tension discharge, but not until recently has the lesson of the lightning been acted upon in a practical, manufacturing way. At Notodden, Norway, was established the first factory especially and solely designed for the manufacture of fertilizer directly from the atmospheric nitrogen. The process is an electrical one and it is on this account that it is so interesting.

The new nitrate industry is at present

The current is alternating and the passage of the spark is instantly followed by an ignition of the neighboring air. It burns with a roar and the arc revolves swiftly like a pin wheel. The illustration at Fig. 1 shows the connections and principle of action, although in actual practice the apparatus is contained in a massive cast iron chamber and the air is fed to the center of combustion through a narrow grate or flue. Fig. 2 depicts a schematic view of the furnace. The two high tension electrodes here observed are not shown in Fig. 2, as this is a sectional view of the hollow arc chamber. The high voltage electrodes are placed at right angles to the plane of the view here given, i.e., as if a pencil were projecting through the page. These electrodes are connected to an alternating current source of 5,000 volts potential. The outlet for the gaseous products is located at the base of the arc chamber shown in Fig. 2. The air is fed into the chamber through the two outer pipes marked *air inlet* and passes through the grate-like discs as the arrows indicate. After the alternating current arc has acted upon the incoming air, the mixture of gas and air emerges through the efflux pipe, which is connected to the water tanks. The alternating current has been found best for this work as the arc, which takes place not in the space between the magnet poles N and S, but at right angles thereto, tends to rise upward, then downward until it breaks. The arc has, therefore, to restrike constantly for every alternation of the current. The gaseous products are drawn off and passed through water towers, containing a weak solution of caustic soda or caustic potash. The product of combustion may be regarded as nitrous oxide—NO. The nitrous oxide passes into an air chamber where it immediately unites with the oxygen to produce the familiar nitrous peroxide NO_2. This passes into a water tower where it dissolves in the water with the formation of nitric acid, HNO_3 and nitrous acid HNO_2.

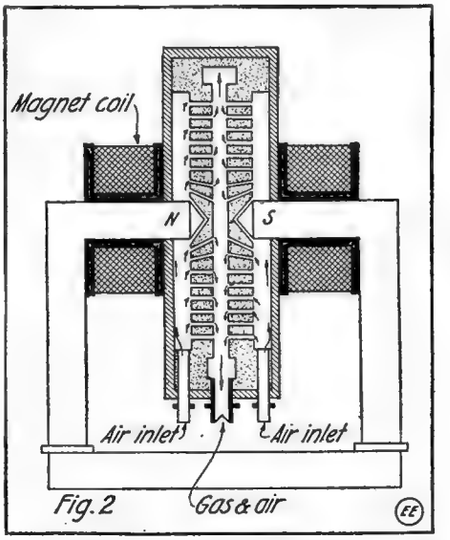


Fig. 2. Perfected Electric Furnace for Reduction of Nitrogen. The Arc Passes Between Two Electrodes Perpendicular to the Plane of the View Shown, and is Acted Upon by the Two Magnet Poles. The Air Inlets, Also the Outlet for the Gas and Air, Are Located at the Base of the Arc Chamber.

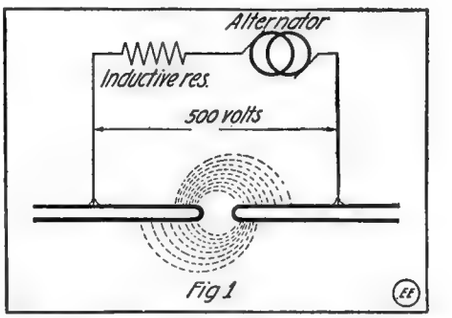


Fig. 1. Elementary Nitrogen Reduction Furnace. The A. C. Arc Causes a Chemical Change in the Air, Between the Electrodes, Yielding Sodium Nitrate, Etc.

These acids then come in contact with sodium or potassium hydrates and react to produce the sodium nitrate or potassium nitrate.

As already mentioned, the natural fertilizer found in such abundance in Chile, is "sodium nitrate," hence it is a feat of no small importance to be able to produce the same substance directly from the air using an electric furnace, the power being obtained, as in the case of the Norwegian nstallations, from water power. Years ago a pioneer experimental installation was built at Niagara Falls. In itself it was a failure, but undoubtedly the United States will in time possess working installations of this sort, now so successfully operated in Europe.

The Birkeland-Eyde electric furnaces which are used in Norway may be seen in Fig. 3. Each of these large circular units are the furnaces containing the special electrodes and a means of supplying the air. This is the most successful nitrogen reduction plant ever installed by any country.

THE ELECTRICAL FLAT.

Modern apartment houses which depend entirely on electricity for cooking are now being built. In each of the 95 apartments in Carleton Court, Buffalo, N. Y., the owner has installed an electric range for the tenants.

Each apartment is further equipped with an electrically operated refrigerator, so that electric service includes heat, cooking and refrigeration, as well as light.

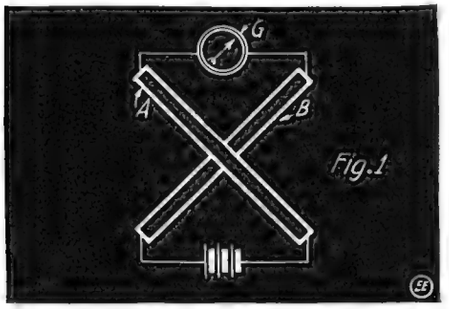
To anyone familiar with apartment life, it is pleasant to think that this equipment dispenses with the necessity of placing the family food in the refrigerator with the ice that has been delivered on the dumb-waiter that is daily used for handling the garbage can.

The Marvels of Modern Physics

By Rogers D. Rusk
Assistant Instructor in Physics, Ohio Wesleyan University

THERMO-ELECTRIC AND MAGNETIC MYSTERIES

IT has often been said that a flow of heat in a conductor is similar to a flow of electricity, but we know now that there is more than a similarity. There is a definite relation between the two which is fundamental in its nature. The most delicate apparatus known to man is being used today to study these phenomena, in an effort to learn more of nature's secrets, but notwithstanding this, the effects which are described in this article are such that they can be created, if not accurately measured, in even the most modestly equipped laboratory.



The "Peltier Cross," Comprising Two Dissimilar Metal Strips, Which, When Connected to a Battery Become Hot or Cold, Depending upon the Polarity of the Circuit

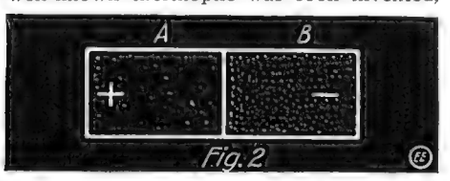
Ever since 1821 it has been known that heat may cause an electric current in a circuit composed of different kinds of metals. Seebeck, who discovered this, joined a German silver and an iron wire together, forming a complete circuit, and upon heating one juncture while the other was kept cold, he found that a current flowed from the German silver to the iron through the hot junction. To complete the circuit, of course, it flowed in the opposite direction through the cold junction. This effect was named after its discoverer, and by further experimentation it was found that all metals can be arranged in a thermo-electric series such as the following, and that when a couple is made of any two, the current will flow from the one above to the one below, through the hot junction:

Thermo-Electric Series.

Bismuth.	Gold.
Platinum.	Silver.
German Silver.	Zinc.
Lead.	Iron.
Copper.	Antimony.

A peculiarity is to be noticed, that the farther apart the substances are in the series *the poorer conductors they are,* but the greater the electro-motive force generated.

By taking advantage of this discovery the well-known thermopile was soon invented,



The Well-Known Thermo-Electric Couple. Heat Applied to the Juncture of Two Dissimilar Metals Produces an Electric Current.

which consisted of a number of such thermo-electric couples in series, and in a form convenient for heating. This arrangement gave a comparatively large current, but still the electro-motive force was too small for any but experimental purposes.

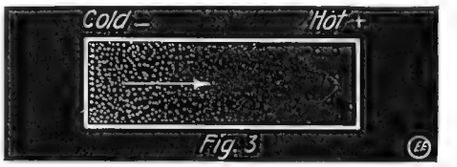
This principle of the thermo-electric couple has been made use of by Professor Boys in an instrument known as the Radio-Micrometer, the sensitiveness of which is marvelous. It is really a galvanometer having a single loop of copper wire for the moving coil, which carries a minute bismuth-antimony couple fastened to a blackened disk. It is said that the heat of a candle three miles distant can be focussed on the blackened disk by a parabolic mirror so as to cause a current to flow in the loop and produce a noticeable deflection. Besides this, several less sensitive thermo-galvanometers have been constructed.

The causes of thermo-electricity have long been a mystery, but they interest us today because of the light they throw upon the leading physical questions regarding matter and electricity. The discussion of the following effects will deal largely with the application of what is known as the free electron theory which has been mentioned in a previous article.

Some twelve years after the discovery of Seebeck, another effect was noticed by Peltier. He found that when a current of electricity is passed through the juncture of two dissimilar metals, that a certain amount of heat is generated or absorbed, besides the ordinary heating effect of the current. In order to demonstrate this he arranged what is known as the Peltier cross, which consists of two bars of dissimilar metals crossing each other as in Fig. 1. The current from a cell passes through two adjacent arms of the cross in a closed circuit, while a deflection is observed in a galvanometer connected to the two other arms. As the battery current does not pass through the galvanometer the current which causes the deflection must be due to the *heating* or *cooling* of the juncture. The fact that the Peltier effect is reversible, that is the galvanometer needle may be deflected in either direction, depending on whether the juncture is heated or cooled, gives us a clue to the nature of the effect. The two metals, we know, are relatively positive and negative, and when the battery current flows in any one direction it is either aided or opposed by the tendency of the couple. When opposition energy is evolved in the form of heat, and when acting together energy is absorbed and the temperature lowered. In Fig. 2 is shown the diagrammatic representation of a thermo-electric couple. The metal having the larger number of free electrons is electro-negative. The Peltier effect will be produced by passing a current from one metal to the other. When in contact a balance is established, and the Seebeck effect will be produced if the juncture is heated, and thus the balance destroyed by virtue of the excess kinetic energy given the free electrons.

A better idea of the existence of these free electrons may perhaps be had from a simple comparison. The free electron theory of conduction assumes the existence of a number of electrons in excess of the number held in molecular combination, just as in a pail of water, formed we know of hydrogen and oxygen in the combination of H_2O, a number of extra oxygen molecules might be dissolved. In fact we may consider the free electrons as held in solution by the metal.

An effect similar to the Seebeck effect may be noticed in a single metal by having its terminals at different temperatures. This effect was first noticed by Lord Kelvin (then Prof. Thomson), and is called after him, the *Thomson effect.* In Fig. 3 the hot end of a metal, say copper, is shown with the fewer number of electrons. This means that the energy imparted to the electrons by the source of heat has driven them farther apart, and as the electrons carry negative electricity, the cold end, with the greater concentration of electrons, becomes negative. By convention we say the current flows in the direction of motion of the positive charges or from *cold to hot.* In some metals as iron, nickel, and platinum the current flows *hot to cold,* and it is



How the Electrons Become Denser at the Cold End of a Heated Metal Bar, in the "Thomson Effect."

suggested that this may be due to the existence of an excess of free *positive particles* in the metal rather than *negative ones.*

A large number of remarkable effects may be produced by superimposing a magnetic field over a conductor carrying heat or electricity. It is a well known fact, upon which the theory of the motor is founded, that a wire carrying a current in a magnetic field tends to move in a direction at right angles to the magnetic field due to the interacting of this field and that of the current. In the same way when a bar of metal carrying a current is placed in a magnetic field, there is an interaction between this field and the field surrounding each electron, tending to cause a motion of the electron similar to the above mentioned motion of the wire. Consequently when such a conductor as ABCD in Fig. 4 is placed in a magnetic field where the lines of force are at right angles to the lines the figure and going from above the paper down through it, then the electrons will tend to move towards the edge CD, although flowing as a current in the direction of the large arrow or from left to right. As represented in the figure, the greatest concentration of electrons will be on the CD side and a sensitive galvanometer will detect this difference of potential between AB and CD, at right angles to the direction of the current. This is termed the *Hall effect.*

The strange yet apparently rigid relation between heat and electricity is shown by the fact that if in the above experiment a current of heat instead of electricity had been flowing in the conductor, the result would have been the same, and a difference of potential would have existed between the sides. To distinguish this from the former effect it is called the *Nernst effect.*

The "Hall Effect," in Which the Electrons Are Unevenly Distributed as Shown When a Bar Carrying a Current Is Placed in a Magnetic Field.

Within the last two decades another effect in a magnetic field has been discovered by Zeseman, which has proved of absorbing interest to scientists. Not alone is the effect interesting in itself but the confirma-

(*Continued on page 207*)

Mimic Atoms and Their Experimental Formation

By Eric R. Lyon, A. B.

Their Meaning*—Part II.

THE geometric groups of Figs. 17 and 18 are mimic atoms because, in the relations between their inner numbers and their total numbers of floating magnets, they imitate the real atoms in the latter's relations between their positive valencies† and their atomic weights. For example, the inner number of magnets of the group listed as carbon in Fig. 17 is 4, the inside square of dots; and the total number of magnets is 12, all of the dots. Correspondingly, the valency of the real carbon atom is 4 and its atomic weight is 12. Another example, the inner number of magnets of the group, chlorine, in Fig. 18 is 7=(1+6). The *inner number of magnets* is counted as the innermost member if the innermost ring equals or exceeds 8 in number, and is counted as the sum of the innermost member and the innermost ring, if the innermost ring does not equal or exceed 8 in number. The total number of magnets is 35. Correspondingly, the maximum positive valency of the real chlorine atom is 7 and the integral number of its atomic weight is 35; the complete weight is 35.45.

The atomic weight considered in this comparison of relations is the integral part of the complete number, which latter may have, besides, a small decimal part not regarded; and the valency considered is the positive, or sometimes known as oxygen valency. The positive valency is now known to be equal to the number of electrons which can be detached from an atom when the latter is transformed into a positive ion. The inner number of floating magnets of a mimic atom therefore stands for the number of electrons which can be detached from the imitated real atom. When these electrons are knocked out, the unfortunate atom is left with an equivalent charge of positive electricity. It is now an ion and it must seek a combination with other ions, the sum of whose excess *negative charge* will equal and balance our particular friend's *positive charge*. In other words electrons escape from some atoms and plunge into others, there to remain for some time. The one set of atoms becomes *positive* ions and the other set becomes *negative* ions. Electrostatic attraction combines the opposite ions into small neutral groups which are the molecules of substances.

To explain why the real atom should so behave itself in regard to the example set for it by our mimic atoms, we should adopt as simple and straightforward a theory as may be possible. It has so far always been found in science that an intricate theory of the elemental parts in any group of phenomena is unnecessary and is soon rendered untenable. We will therefore regard a typical atom as consisting of nothing more intricate than a small ring of positive electricity, maintained as a ring—instead of as a smaller spherical nucleus such as is the electron—by its own rapid rotation; and in this atom there shall also be a plane group of electrons whose negative charge equals the positive charge of the ring, and whose electrons are held inside and in the plane of the ring by an electrostatic attraction between them and the ring which varies directly as the distances involved, instead of obeying the customary inverse-square-law of forces, which, we assume, does not operate dominantly inside of a certain critical atomic range determined by an elastic limit in the ether itself. Atoms of this type are shown at (9), (11), (12), and (13) of Fig. 19. They are nothing more than rings of positive electricity having inside of them groups of electrons which are identical in number and arrangement with the numbers and arrangements of the floating magnets in the mimic-atom groups of Figs. 17 and 18.

In this case and with the force law assumed, it may be shown that the electrons are held inside, and in the plane of the ring, and that they are attracted toward the center of the ring by a simple resultant force which varies directly as the radii from the electrons to the ring center. It now becomes manifest that the inside members of an electron group are the ones most easily ejected, and in this lies the explanation of the positive ion valency.

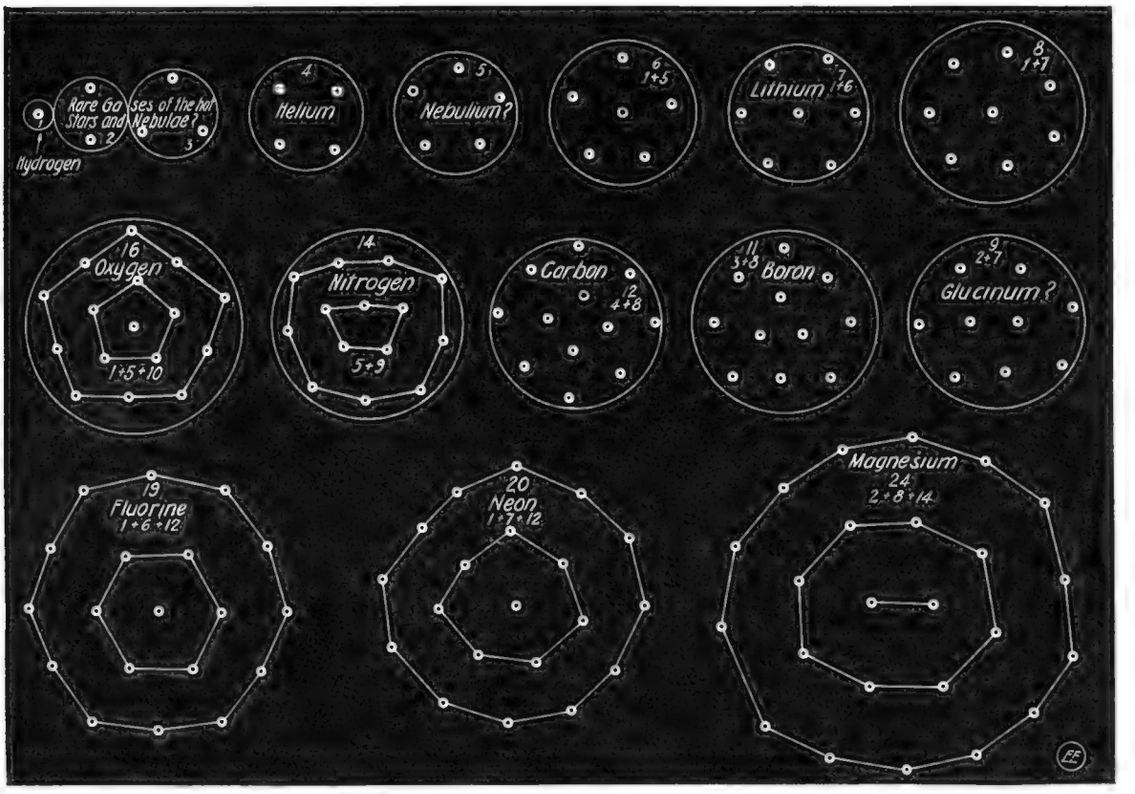


Fig. 17, Chart 1, Showing Actual Groupings of Floating Magnets. The First Paper, in the June Issue, Explained in Detail How the Magnetized Steel Needles Are Mounted on Cork Floats. These Are Set in a Tank of Water and Under the Influence of a Magnetic Coil, Excited by Batteries, the Needles in a Very Uncanny Manner Take Up One of the Positions Here Shown. The Grouping Followed Depends Upon the Number of Floating Magnets Used.

Can we also explain the negative ion valency? Nature has given us a very good hint to begin with. It is the fact that the negative or hydrogen valency of an atom is equal to the number 8, subtracted from the positive valency. For example, the sixth family of atoms in the periodic classification of the latter includes oxygen, sulphur, and several others. These atoms have 6 for their positive valency and —2 for their negative valency. One of them can lose 6 electrons or gain 2, according to its condition, —2=6—8.

In (10) of Fig. 19, we have an example of the two valencies of the sixth family of atoms. The molecule there pictured is that of anhydrous sulphuric acid, H_2SO_4. The sulphur atom acts there as a positive ion of 6 charges, having lost 6 electrons. The 4 oxygen atoms are negative ions of 2 charges each, having gained 2 electrons each. The electrostatic balance of the molecule is completed by the 2 hydrogen ions, each of which has lost its one and only electron.

The fifth family of atoms, represented by nitrogen and phosphorus, has 5 for its positive ion valency and —3 for its negative ion valency; —3=5—8. The fourth family, represented by carbon and silicon, has 4 for its positive and —4 for its negative valencies, —4=4—8. The first, second, and third families do not have negative ion valencies unless, perhaps, in rare and unstable cases. The seventh family, represented by fluorine, chlorine, bromine, has the positive valency of 7 and the strong negative ion valency of —1; —1=7—8. Most remarkable is the combined eighth and zero families. That the two should be considered together is evident from the fact that wherever an element or atom, such as helium, neon and argon, appears in the zero-inert family none appears in

*By all means read the first paper on this subject in the June issue.

†Valence. The degree of combining power of an atom.

the corresponding place in the eighth family, but there is left a vacancy there. Likewise, wherever one of those peculiar small groups of closely allied atoms, such as iron, nickel and cobalt, or platinum, iridium and osmium, appear in the eighth family, the corresponding place is vacant in the zero family. The characteristic positive valency of the eighth family is 8, but the family has no negative valency—then the negative valency is 0; 0=8—8. The elements of the zero family are the inert gases. Their atoms have no valency—theirs, then, is the negative valency of the combined zero-eighth family.

This would seem to indicate, that, wherever the second innermost ring of electrons in an atom group is itself, with at least 2 or 3 electrons greater than 8 in number, the first innermost ring and the innermost member may together become, by the acquisition of electrons entering the atom from without, a rotating innermost ring of 8 but of not greater than 8. We say a *rotating innermost ring*, because an electron cannot fall into an atom under the action of the latter's electrostatic attraction and remain there unless the electron is able to rotate around the atom's center of attraction which is the center of the positive ring.

If an electron enters an atom nearly along the axis of rotation of the positive ring, its momentum will carry it right on through and out of the latter's immediate field on the other side to a distance equal to that at which the journey was begun—except for loss of energy by radiation, or from deflection by other atoms—and, if undisturbed, the electron will return on its course back through the atom and will describe a series of oscillations. It may be shown, too, that an atom's immediate field of force acting upon a resting electron placed within the field at any point except those in or almost in the positive ring's plane of rotation, is such as to cause the electron to oscillate in the manner above described, except that the amplitude of the vibration does not, of course, pass beyond the immediate-field-range; and is such as to cause the electron to pass perpendicularly through the rotation plane at a point very near or at the center of the ring. In this last case, furthermore, the excess vibrational energy of the particular electron will almost instantly be given up to the rest of the electron group, and the whole group will vibrate with much diminished amplitude back and forth through the ring, bellying out at its middle somewhat like a stretched diaphragm.

We may mention here that the loss of energy by radiation in this latter case will be extremely slow—this from the theory of

(*Continued on page 208*)

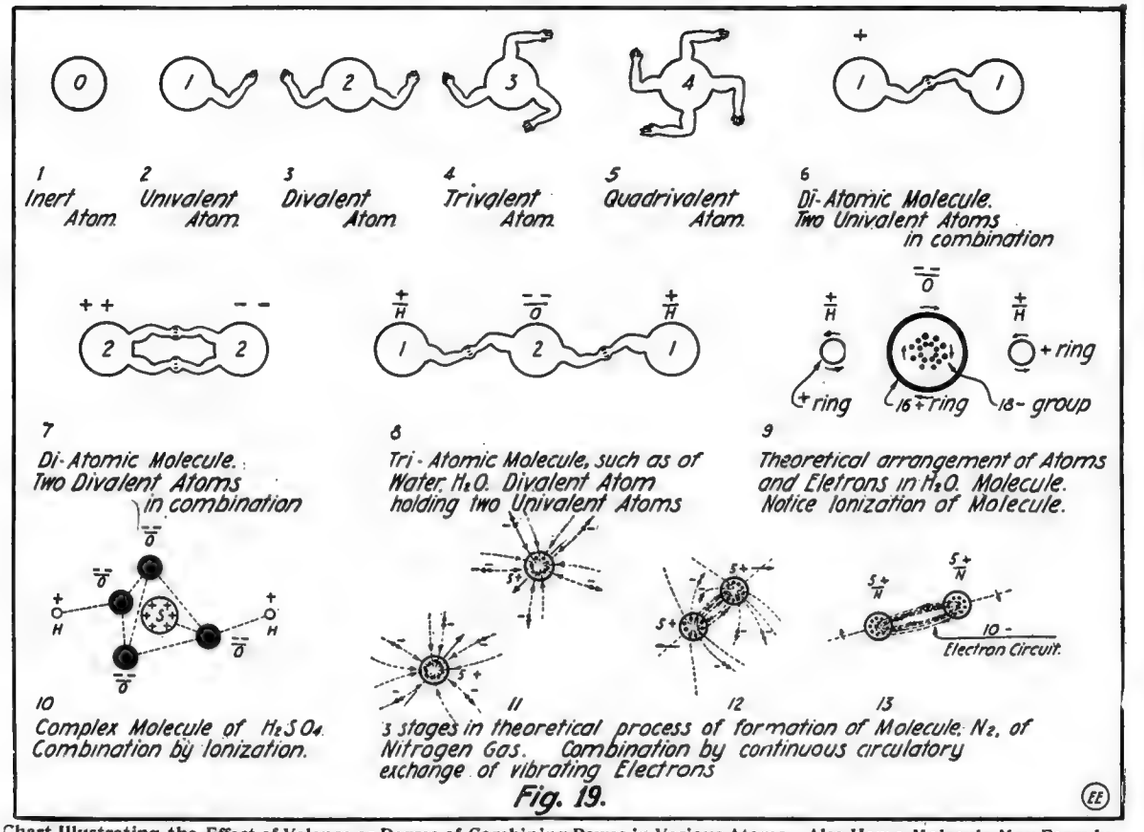

1 Inert Atom
2 Univalent Atom
3 Divalent Atom
4 Trivalent Atom
5 Quadrivalent Atom
6 Di-Atomic Molecule. Two Univalent Atoms in combination
7 Di-Atomic Molecule. Two Divalent Atoms in combination
8 Tri-Atomic Molecule, such as of Water, H_2O. Divalent Atom holding two Univalent Atoms
9 Theoretical arrangement of Atoms and Eletrons in H_2O. Molecule. Notice Ionization of Molecule.
+ ring
16+ ring
18- group
10 Complex Molecule of H_2SO_4. Combination by Ionization.
10 - Electron Circuit
11 12 13 3 stages in theoretical process of formation of Molecule N_2, of Nitrogen Gas. Combination by continuous circulatory exchange of vibrating Electrons
Fig. 19.

Chart Illustrating the Effect of Valence or Degree of Combining Power in Various Atoms. Also How a Molecule May Form by a Certain Action of the Electrons.

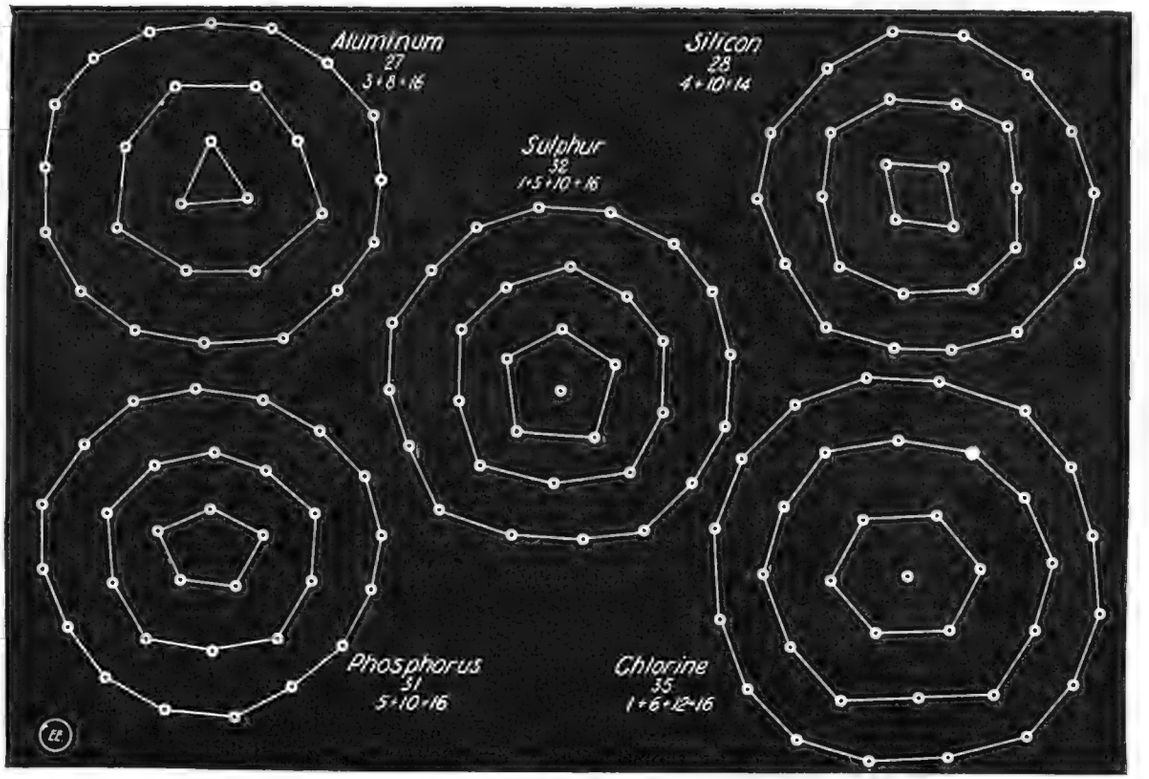


Fig. 18, Chart 2, Illustrating Further Group Figures Which a Certain Number of Floating Magnets Will Assume. The Magnets Will Take Up These Positions in a Very Positive Manner. Note the Equilibrium of Each Magnet.

Trailing Aravilla

And How the Marvelous Electromatograph Came into Action

By George Frederic Stratton

THERE was an air of listlessness and perhaps a touch of scorn on the General's face as he watched Professor Gunzri adjust the wire connections of the odd-looking *Electromatograph,* securing current through the Teck Duplex-Wireless Power Line.

"General!" exclaimed Cawthorne, the young millionaire exploiter of the inventions which had made a world renown. "Allow me to suggest that you direct one of your officers to write some communication on a slip of paper, and at the same time to put his thoughts on something, if possible, quite different to the subject he writes upon. That will give this apparatus a test."

The General's eyebrows went up and his shoulders shrugged, but he turned to the group of uniformed men who were standing about the Headquarters tent.

"Lieutenant Travers!" he directed, "do as Cawthorne requests."

"A single paragraph or a short sentence will suffice," smiled the millionaire. "I think it would be wise to withdraw where you'll have no eyes on you to bother you at all."

Travers left the tent and returned in a few moments with a paper which he handed to the General. Professor Gunzri had pulled a small metal slide out of the machine and now observed:—

"If the General will place the paper—writing down—on this slide we can at once make the test."

"Just a moment!" interrupted Cawthorne. "It will show more fully the marvelous exploits of this apparatus if Lieutenant Travers first writes, on another paper, exactly what thoughts he had when he wrote the first."

The Lieutenant glanced at the General; got a nod of approval and instantly prepared another paper which he handed to his Chief, who, without glancing at it, folded it under his belt.

Then Gunzri threw the switch. Instantly the fine wire screen supported above the cabinet began to glow with incandescence, followed by a strange quivering pulsation of light and shadow as of a lake of molten metal disturbed by a breeze. Outlines began to appear, forming themselves into trees and a building, until with a final quiver the mistiness cleared and a picture stood out as sharp in detail as though engraved on glowing steel.

The scene showed an old typical shingle-walled New England home facing a broad river. Gliding down the river was a lumber schooner, and on the lawn under a great oak was a table spread around which sat a number of guests, laughing and chatting gaily.

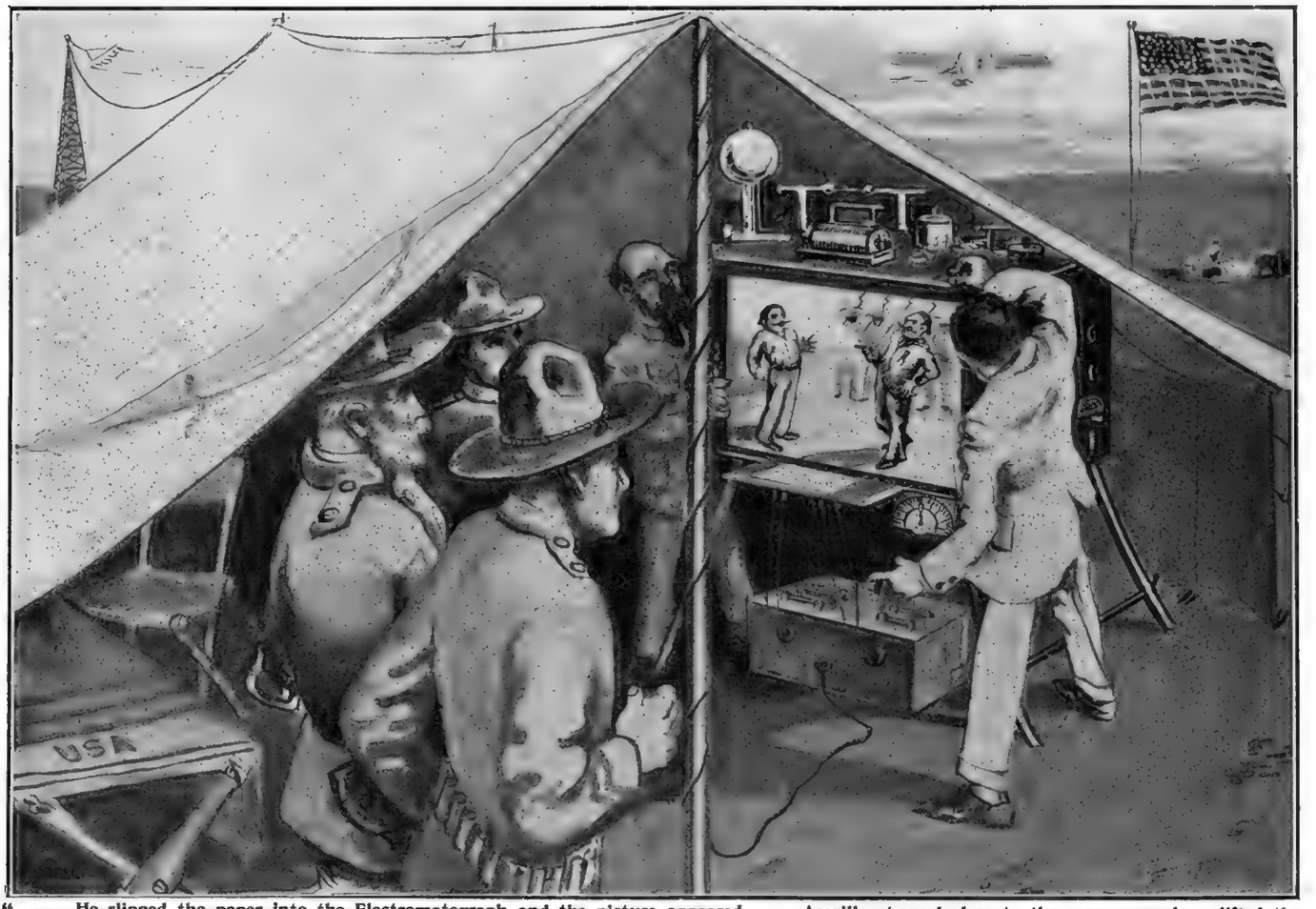
Then the picture dissolved into another. A farmhouse was shown in the background and in the foreground, concealed from the house and barns by a thick clump of cedar, was Lieutenant Travers holding in his arms a girl who was clinging to him with adorable tenderness and tenacity.

There was a gasp from that officer and over his bronzed handsome face came a deeper flush of the red tan; but as he glanced sharply at the other officers he saw no ribald looks—nothing but amazement and appreciative sympathy.

Gunzri switched off and as the incandescent picture faded out he pulled the slide and drew out the paper, handing it to the General.

The rugged, gray old warrier read it aloud:—

"My home—my parents' home—is on the banks of the Kennebec River, above Augusta. During my last leave of absence my parents celebrated their silver wedding and many old friends were there to congratulate them."



". . . . He slipped the paper into the Electromatograph and the picture appeared . . . . Aravilla stepped close to the man, savagely uplifted the downcast chin and peered into his face . . . . he whipped out a revolver and put three shots into the poor wretch's body."

Then he turned to the Lieutenant:—"Was that picture on the screen your home, Travers?"

"It was, Sir. Absolutely correct in every detail. The company had dinner on the lawn just as it showed."

"And the second picture, Lieutenant. Was that what came into your mind while you wrote the first?"

"It was, Sir!"

The General drew the second paper from his belt, glanced at it and then read it aloud:—

"As I wrote the first paper my thoughts went to this girl I left behind me and my farewell with her as I left to join the colors. Her home is sixty miles inland from the river."

There was intense silence when he finished, but on every gaunt, bronzed face was corrugations and brows drawn together with perplexity and deep study. Presently the General said sternly:—

"I understand, Lieutenant, that you never met the Professor or Mr. Cawthorne before coming into this tent?"

"Never, General!"

"Nor ever held any communication with them?"

"Not the slightest, Sir!"

The General turned to the other officers: "Gentlemen, I am going to request Professor Gunzri to make the same explanation of this astounding apparatus to you as he made to me on his arrival this morning. It may lead to some change in our campaign. Now, Professor!"

The thick-necked, broad-shouldered, but almost dwarfed man faced the officers.

"Gentlemen! My theory of the action of this electromatograph is purely an abstract one. Of course you know that when a man writes anything his thoughts may be concentrated upon the matter on which he writes, or—as frequently happens—they may wander over a series of impressions or occurrences having more or less bearing upon the subject matter of his writing. Evidently those rapidly recurring ideas and memories do, by some electro-magnetic action which I do not pretend to explain, flow through his nerves to his pen and become incorporated with the writing. Then, when we place the writing in this apparatus, those incidental thoughts, preserved through the written words, are through the action of the electric current transferred to the screen in the form of actual pictures, as true I have always found as a photo."

"A species of electro-mental transference," suggested Cawthorne.

"Possibly! We as yet so little understand the principles of electricity that speculation upon one of its marvels—accidentally discovered—is at present fruitless. We know some of its possibilities, and knowing them who dares say that it has any impossibility. We know that power, equivalent to two hundred thousand or more horses, can be sent through a small wire for hundreds of miles and instantly exert that power for work. We know that its pulsations will travel unerringly through a three or four thousand mile air space to a certain defined goal. No man can say how! No man dares define its limitations!"

"Although the mechanical details of this apparatus were designed by myself, the actual impulse or principle on which it operates is as mysterious to me as to you. It not only shows plainly what the words on the paper actually mean or refer to, but it shows as plainly what the writer had in his mind when writing."

He nodded his massive iron-gray head emphatically as he concluded.

"Follow with your idea of its practical use to the Army, Professor!" demanded the General.

"Mr. Cawthorne is the man to do that," asserted Gunzri. "It was his first thought when I introduced myself to him, hoping for help to make the apparatus, and he placed his fine experimental shops at my disposal, and ample capital."

The General glanced at Cawthorne, who commenced:—

"The Professor is right. My first thought of the use of that machine was that it might detect for you the correctness or incorrectness of the information you have been getting in this campaign from the Mexican natives and from the Mexican authorities. It seems to be pretty well assured that much of such information has been for the special purpose of leading your command away from the bandits and insurrectionists instead of to them. When this marvelous screen recalls the thoughts of the writer as well as what he writes, it will certainly show lies as well as truths."

"It's worth trying," muttered the General. He opened a dispatch case and drew out a letter on dirty rough paper.

"This is the note brought in by that peon, stating that Aravilla and his party had gone into the Cuicatlan country, and that statement was, as usual, a mistake or a deliberate misstatement. Try that, Professor!"

Gunzri slipped the paper onto the slide, threw the switch and the uncanny incandescence commenced. The picture showed a group of Mexicans in a weird cañon and murmurs broke from the officers as they saw, in the most gaily uniformed man, the well-published figure and face of the atrocious chief, Aravilla.

WATCH FOR THE AUGUST NUMBER

Just a few of the numerous and extremely interesting articles scheduled to appear in the August issue of The Electrical Experimenter are cited below. Articles previously announced and not appearing in the present number will be published at a later date, just as soon as we find space for them.

"Those Electric Light Bills and how the Housekeeper can reduce them —An article for Father and Mother." By F. H. Sweet.

"Ridding Trees of Insects by Electricity."

"Frequency Meters—How They Work." By M. B. Sleeper.

"Marvels of Modern Physics." By Rogers D. Rusk, B.Sc.

"Modern Commercial Radio Receiving Sets."

"Experimental Chemistry—Part III." By Albert W. Wilson.

"Ultra-Violet Light and Its Possibilities." By Samuel Cohen.

"Making Selenium Cells."

"Water Wheel Drives for Private Lighting Plants—Part II." By H. Winfield Secor.

"Baron Münchhausen's New Scientific Adventures." By Hugo Gernsback

"The Liquid Rheostat in Locomotive Service."

"The Music Optigraph—An Electrical Short-cut to Music."

Over fifty other articles will appear in the August number, besides all the usual departments.

Before him, seated on a rock, was a native girl, writing. A peon appeared and Captain Berchall muttered to the General:—"That is the peon who brought that note, Sir! The gash on his left cheek is unmistakable!"

The girl finished writing and with an audacious, triumphant smile handed it to Aravilla, who in turn gave it to the peon.

Then the picture dissolved into one showing a different scene. It was a narrow gulch with almost perpendicular mountains on either side, and working through it was Aravilla's party, riding steadily. Then it faded out.

The General shot a steely glance at the Professor and Cawthorne, then turned to his officers:—

"Gentlemen, we have got to believe that there is no conspiracy between these two men to deceive and mislead us with false pictures. Such damnable treachery would have but one result. Take out that paper, Gunzri. On the back is a translation. Read it!"

Gunzri read:—"This is written by a wretched girl in the power of the brutal Aravilla, hoping that the noble Americanos will overtake him and rescue me from him. He has just commanded his army to go at once over to the Cuicatlan country, so that he can come upon you from the Naranjos Cañon.

My brother, who is a camp helper, will try to escape with this and bring it to you. Do not hurt him. He is forced to work for this army.

"Isa Castellon."

"Now!" growled the General, "if that first picture was true, the girl lies! We saw that Aravilla dictated that note and himself handed it to the peon who brought it in.

"And we know that he never went to the Cuicatlan region. Captain Berchall, who returned with the search squadron this morning, reports that no trail signs of any party were found. Now! What's the meaning of the second picture? Did anyone recognize that gulch they were going through?

"There's one man who perhaps would, General, if he saw the picture. The scout Berkhole! He came back into camp with us this morning."

"Order him to come here!" directed the General. "Now, gentlemen, all; not a word to Berkhole as to this apparatus or the pictures. If there is any value in it all, the operation must be kept absolutely secret.

In a few moments Berkhole appeared—a typical Texan frontiersman.

"Berkhole," said the General, "we have some views here of the country that we want you to look at carefully and see if you recognize them. Gunzri, show them again!"

The Professor replaced the paper, threw the switch and a gasp broke from the scout; "Moving pictures, Eh! Aravilla, by heaven! Don't know that place. It might be mos' anywhere in any of these ranges—here or elsewhere."

The picture changed as before and Berkhole glared as he saw the great band of Insurrectionists trotting through the Cañon.

"Yes! I know that place well. It's Ixcatepec Gulch; leads through to Chupaderas!".

"To Chupaderas!" exclaimed the General. "Just north of us?"

"That's the place, General! I was through there with a band of prospectors less'n a year ago."

The General's face contorted with a fiercely grim scowl. "You may go, Berkhole. Say nothing outside about the pictures you have seen. That is an imperative order!"

"Now, gentlemen, if this is all correct it might have been very serious for the entire command if we had not known it. Aravilla has worked to the north of us probably to attack our line of communication, while Carasco, with ten thousand men, is advancing rapidly from the south. They'd have had us between them. Captain Berchall lead your troops north and cut off Aravilla! Travers, order out a squadron of gyroplane scouts over that Ixcatepec Gulch. Instant work, gentlemen!"

As the two officers left, Cawthorne saluted the General and exclaimed:—

"There came in with the convoy this morning two of our Gravitation Nullifiers, Sir. I think this is their opportunity."

"Ah-h! Those marvelous machines that put the Japo-Chinese army out of com-

(*Continued on page 217*)

The RADIO LEAGUE of AMERICA

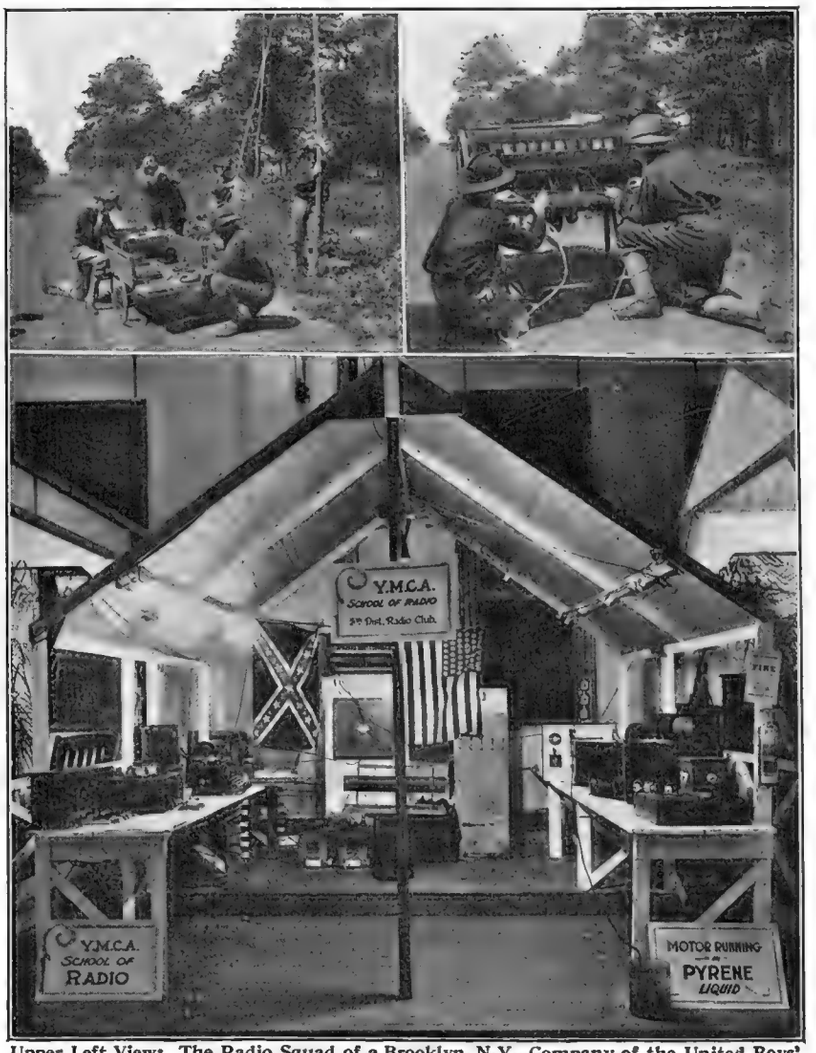
HONORARY MEMBERS
CAPT. W.H.G. BULLARD, U.S.N. NIKOLA TESLA.
PROF. REGINALD FESSENDEN. DR. LEE DE FOREST.

H. Gernsback

Radio Club Activities

THE Radio Clubs throughout the country have been particularly active the past few months, and we hope to hear of still greater efforts by the amateur wireless fraternities in the near future. Of course this does not mean that you are to "jam" the ether continuously with your strongest waves in an effort to show the power of your set or to attempt some extraordinary transmission record. It's a fine idea to try out your transmitting set, to be sure, as possibly you may have in use a new wrinkle, which means higher efficiency, but such tests should be conducted with a show of decency and respect to your brother "Radio Bug." True, he may have only a ¼-inch spark coil for sending, and a spark that sounds—well, never mind, but on the other hand that chap may be a genius and intensely interested in the reception of long distance signals. Quite possibly he may be experimenting with a new form of amplifier, which, after he is through developing it may be of undreamed of value to you.

Wherever possible we always recommend the radio experimenter to join a local society or club composed of men interested in this subject. If there is no club in your town or city, why not start one? It's easy and, by communicating with other radio amateurs in your locality about the idea, a start can be made at practically no cost at all. Such preliminaries are commonly handled by wireless or by letter. Two heads are better than one, is an old saying, and so it is in a radio organization. Little is actually gained by going it alone, and moreover it's twice as hard to solve many of the problems and studies encountered as when you can bring these before the club's technical staff. Many clubs have arrangements made with some local high school professor or municipal engineer, whereby they can obtain expert advice on difficult questions. Individual members rarely ever possess a wave meter or decremeter, two very important instruments, but even a small club may, by individual taxation or by a special campaign, raise sufficient revenue to purchase this highly desirable equipment. Again, most clubs have a small laboratory and shop with at least a lathe and drill press, where the members may wind their coils and perform other work which is difficult to accomplish at home perhaps, as about one experimenter in a hundred possesses a lathe of respectable size, or voltmeter that reads in *volts* and not in some fancy division of that honorable unit which may be anywhere from a third to three-quarters of the correct current value.



Upper Left View: The Radio Squad of a Brooklyn, N.Y., Company of the United Boys' Brigades of America, on Duty. Upper Right: Telegraph Corps Establishing Connections. Below: Excellent Wireless Exhibit of the Fifth District Radio Club of New Orleans, La., During the Jovian's Electric Show.

The photographs on this page show some of the work done by radio clubs. Perhaps other associations and members of the Radio League of America will gain suggestions for their own activities from the pictures which have been published.

On the first Saturday night of last April a number of radio amateurs of New Orleans, met in the Y.M.C.A. building and discussed the formation of a wireless club that would cover the Fifth Radio District of the United States. A staff of executive officers for the organization was selected at that time. The club is now well known to amateurs who were not aware of its formation previously, and applications are coming in every week.

Recently the Jovian League of New Orleans announced in the daily papers that it was going to give an electric show. The Fifth District Radio Club immediately got busy. With only a week in which to get the amateurs together and secure the loan of their instruments, it set out upon the task. Some amateurs were not at home and therefore the sets could not be obtained. Saturday night arrived and still the exhibit was lacking some instruments. Monday night the club opened its exhibit with a number of wireless sets in the booth shown in the photograph, which was also occupied by the Y.M.C.A. wireless school. As the week progressed, sets from all sections were brought to the show nightly, but because of lack of space they could not all be exhibited. Those exhibited were of the latest panel type sets designed and constructed by members of the club. There were also some separate instruments exhibited, but the finest complete set won the medal.

In the rear of the booth is a panel type transmitting set, under construction by W. A. Taylor. On the table to the right is the transmitter of G. P. Reynolds; next is an up-to-date receiving set of another member. On the end of the table is seen one of H. V. Roome's oscillaudion bulb detectors. At the top of the booth is a signal post with a number of lamps on it, which were used for communication with the booth of the Y.M.C.A. radio school located on the other side of the building. Besides many other instruments exhibited in this booth, there was an auxiliary set from the radio school. This consisted of a ten-inch coil, three storage cells, the panel charging board and Marconi receiving set. As this photo was taken on the last day of the show, many sets were removed which consequently do not appear in this picture.

The Fifth District Radio Club would like to hear from radio amateurs in the fifth district, who have not yet received a letter from the secretary. Address all

(*Continued on page 209*)

Editor's Mail Bag

Under this heading are published communications from our readers of general interest to all concerned. In order that letters shall receive proper attention, we earnestly request to make them as short and concise as possible. This is essential on account of the great amount of mail received daily.

No attention can be paid to unsigned communications, but on request we will withhold the correspondent's name.

EDITOR.

CONSTRUCTIVE CRITICISM.

Editor To Electrical Experimenter:

I sorry not know writting enough English to make myself understood to you as I wish but think that you will understand me.

I have received your instructive magazine until November. As I am Operator and serius experimenter your Magazine is to me very much interesting, for what send herewith draft Bank for $1.50 to renewal my subscription for another year start from number of December of 1915.

Your Magazine at present seems me good but they would be best, and I shall like read throught in Magazine any articles devoted to the side practical of serius experimenters and operators of wireless (not only some articles devoted to the "poors amateurs" and to yours smalls spark gap). Very good articles writting considering worthy and fully the differents apparatus of a equipment about 1 to 2 K.W. power; give out the directions ideas fresh from authoritative personal experience of the writter about the severals troubles and faults of the differents apparatus of a set sender.

To shown the mains characters which mean or indicate that a fault is just present; how know a short circuit on Primary or Secondaries of transformer of low frecuency, what fail spark, when break down condenser main and Preventer Kick back; give out methods of testing for continuity this circuits for means of buzzers, phones, galvanometers, lamp light, etc., out lined sheme used on each test, which tell best that very much words.

It would constitute a indeed usefull Magazine betters that a book, it will be *recoppilacion* complete information of valuable directions and O.K. help to operator. In actual practice of the working the nature of the service demanded from the apparatus there are occasionals bad injury or breack down or serius faults arise in course working. If then the operator-reader of "E.E." take the Magazine in order to inquire a practical rule, a very good method to localizate and test the fault and know how, be rectified. Your very trully,

PROF. RICARDO MORAN PEREIRA,
Capitania del Puerto.
Guayaquil, Ecuador, S.A.

[*We purposely have copied verbatim the letter of our distinguished subscriber. Handicaped as Prof. Pereira is by his lack of English, it is gratifying that The Electrical Experimenter fulfills its mission even in Ecuador. Although not very familiar with our language, Prof. Pereira offers constructive criticism—the kind which helps to make the magazine better and greater. We shall publish in the near future several articles touching upon the subjects as outlined by our far-off subscriber.—Editor.*]

SUPPLEMENTS ARE WANTED.

Editor Electrical Experimenter:

I greatly enjoyed the splendid supplement of Marconi in your August, 1915, issue, as well as the "How-to-Make-It" supplement in the September issue. I am certain that I express the wish of thousands of other readers of your wonderful publication by asking for more of such supplements. Won't you let us have more?

C. H. GAMMONS.
Cambridge, Mass.

[*We have in preparation now a series of supplements which will be included with The Electrical Experimenter, beginning either with the August or September issue. Among the supplements, to be printed on fine paper suitable for framing, we only mention the following: Edison, Tesla, Fessenden, De Forest, Hertz, etc.—Editor.*]

THE READER'S AND THE PUBLISHER'S SIDE.

Editor Electrical Experimenter:

To begin with, I apologize for the liberty I am taking in what follows:

Much has been said of your valuable magazine, and much remains to be said. Your paper has grown rapidly in size and circulation. I venture to say that the greater part of your subscribers are electrical experimenters or those interested in the field of electricity, including the amateur wireless operator. I praise your magazine and also criticize it. In doing so, let it be understood that I believe I am expressing the opinions of the majority of your readers.

To the reader who has observed the greater part of the growth in technical periodicals in this country, the case of your magazine closely parallels that of "Popular Electricity." Your magazine if you are not careful may degenerate in much the same way as the one just mentioned has in the eyes of the student of electricity. For instance, the greater part of the latter magazine's successor is taken up with war pictures, reports on recent electrical novelties for the massage parlor or the barber shop, or things equally ridiculous from the standpoint of the student who subscribes for a magazine because he believes that it will contain something worth while and of benefit to him.

Lately your magazine has begun a slight process of *degeneration* (pretty strong, isn't it?)

Your new policy, "The Electrical Magazine for Everybody," instead of "The Electrical Magazine for the Experimenter," is a cause for this statement.

It seems as though you are tempted to publish material such as some of the other semi-technical journals do and which are only space fillers as far as the experimenter is concerned.

Does it have to be proven to you that there is a real need of a magazine of a nature that will truly meet the needs of your experimental readers, Mr. Gernsback? You need not accept my word, try a vote amongst your readers on the subject, stating the question to them! In endeavoring to extend your policy to cater to non-technical readers, your magazine will fail to fulfill the needs of its present readers.

Several of the other technical and semi-technical journals cover the popular field, and yet *your* magazine, almost our last resort, would leave us also? I could write indefinitely reasons why you should limit the field of your magazine to those really interested in science and cover *that* field well, but I shall not do so. Your work for the young Edisons has been marvelous, and I tell you that most of us appreciated your efforts, and there is a real need, and it is growing, for a magazine of your type that fulfills it.

Now, Mr. Gernsback, if you have read this through and tolerated the crudity of this message, which is sincere at heart, your readers would like to see your answer in the next number.

In closing, I will say that we appreciate the marvelous growth of your paper, and as a whole it is fine, and if it keeps getting better, we will do all in our power to boost your circulation. By the way, send us some more of those supplement pictures of Edison, Tesla, etc., for they are appreciated by us.

Begging for toleration, I shall now close.

Cleveland, O. A. S.

[*Our correspondent's points are well taken, and no doubt justified. There are, however, several points which we desire to make clear for the benefit of all readers.*

We started out by publishing a purely experimental journal. For two years, as our volumes No. 1 and 2 will attest, nothing but experiments, "How-to-make-it" articles, as well as "Constructor" material were published. The journal then had sixteen pages of text matter. The subscription price was 50 cents a year. Although persistently and widely advertised, the circulation never rose above 10,000 copies. On this small circulation we could not get advertisers, with the result that at the end of the second year we had lost nearly $8,000.00. Apparently the low price of 5 cents a copy and 50 cents a year was not an inducement. Had we continued along our original lines, the "Electrical Experimenter" would not now be in existence.

However, by choosing the wiser path, by making the magazine more general, we are now in a position to give the experimenter at least twice as much experimental text as last year. In magazines, as in life, you cannot have everything. When eating pie, you are expected to eat the crust, too, though you may not always like it.

On the other hand, have you given due consideration to the man who just starts in the study of electricity? Within three years he may be as enthusiastic a "bug" as yourself. But how will he get there if we don't help him? Would you deprive him of the knowledge which he obtains now due to our articles which seem superfluous to you? You, too, had to begin once, why be less charitable to others? Furthermore, never forget that the advertiser "pays the freight." Just now the magazine costs us more than what we get for it. If it were not for the advertisements we could not subsist for three months. But we could not get advertisers when our circulation was 10,000 copies and our text filled with purely experimental articles. Now, with a circulation of over 64,000, we can hold our advertisers; on the other hand we would never have reached this point if it were not for the fact that we made part of the magazine more general.

We believe that no one will dispute the fact that to-day we are giving more experimental matter and better matter than any other magazine in print. We are bettering and enlarging each department constantly. Already with this issue we have added eight big pages. Is it not worth while for the true experimenter to accept The Electrical Experimenter as it stands to-day, than not see it published at all?

And now that we have told you our side of the story, we have a strong suspicion that, in spite of his criticism, A. S. reads the magazine from cover to cover, even though he is familiar with some of the articles!—Editor.]

Modern Radio Transmitting Apparatus

THE development of the radio art during the past few years has been so rapid that it was difficult for the various technical periodicals to keep pace with it. The purpose of this and a subsequent article is to show the readers of this journal several new and unique forms of apparatus, which have not been shown and described before.

The first and most important piece of apparatus in the modern radio transmitting station is the generator. Although several forms of power driven alternators have been developed the direct-connected steam turbine type is most suitable for land station work, or steamship service. Such an alternator is illustrated in Fig. 1. This machine has an output of 2 k.w. at 500 cycles. The exciter is placed at the left of the alternator, which is driven by a turbine, while a rotary gap is also mounted on the same shaft at the left, and is used as an alternative to the quenched gap. A number of these generators are being used on the U.S. Government fighting craft, and have given very satisfactory results.

It is undoubtedly known to the radio experimenter and engineer that the spark "gap" is the most inefficient instrument of the present type transmitter. Although several forms of gaps have been evolved during the past, the quenched gap has proven superior to all others. This is due to the increase of sparking surface and also because the spark takes place in a partial vacuum. The discharge space is larger, and thus the radiating surface is increased. This helps to keep the gap cool during its operation, although in high power transmitters they heat up to such an extent that the gap loses efficiency because the space between the electrodes becomes ionized. In order to overcome this defect of the quenched gap, ordinary fans have been employed for cooling the electrodes, but this was only practicable for gaps employing power 2 k.w. and under. The air blast gap, however, is more efficient. Fig. 2 clearly illustrates a quenched gap with an air blast motor. The air is forced through a flexible pipe and into an enclosing chamber which holds the gap. The sparking surfaces are formed of sheets of *pure silver,* which are riveted and soldered in place.

The radio engineer has been constantly laboring upon the gap problem, and finally a new type of quenched gap has been brought out by a prominent radio concern. This can be seen in Fig. 3. Each of the tubes contains two gaps in series. The cylinders are mounted on an insulating panel with an opening, which allows a strong blast of air to pass from an electric fan. The ease of replacement of a defective unit and air-tight sealing facilities in each of the several units are the strong points favoring this type. The sparking takes place between two concentric cylinders, centered by means of insulating cones, accurately turned. The sparking surface is heavily plated with silver, as it has a higher electric and heat conductivity than the other metals. Lately, however, a prominent radio engineer of Brooklyn has found iron quite satisfactory for electrodes; the only reason it was not particularly efficient was that the metal became hot, that the space between the electrodes ionized to such an extent, that the air space became practically a conductor; this naturally did not permit proper sparking. The connections, Fig. 3, are made from the outer cylinder by means of a metallic strip, resting on the tube, while the inner electrode

(*Continued on page 204*)

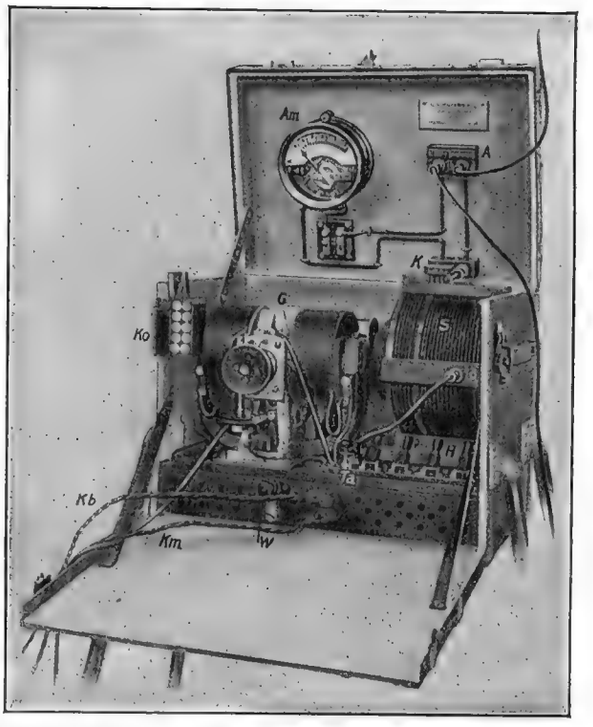
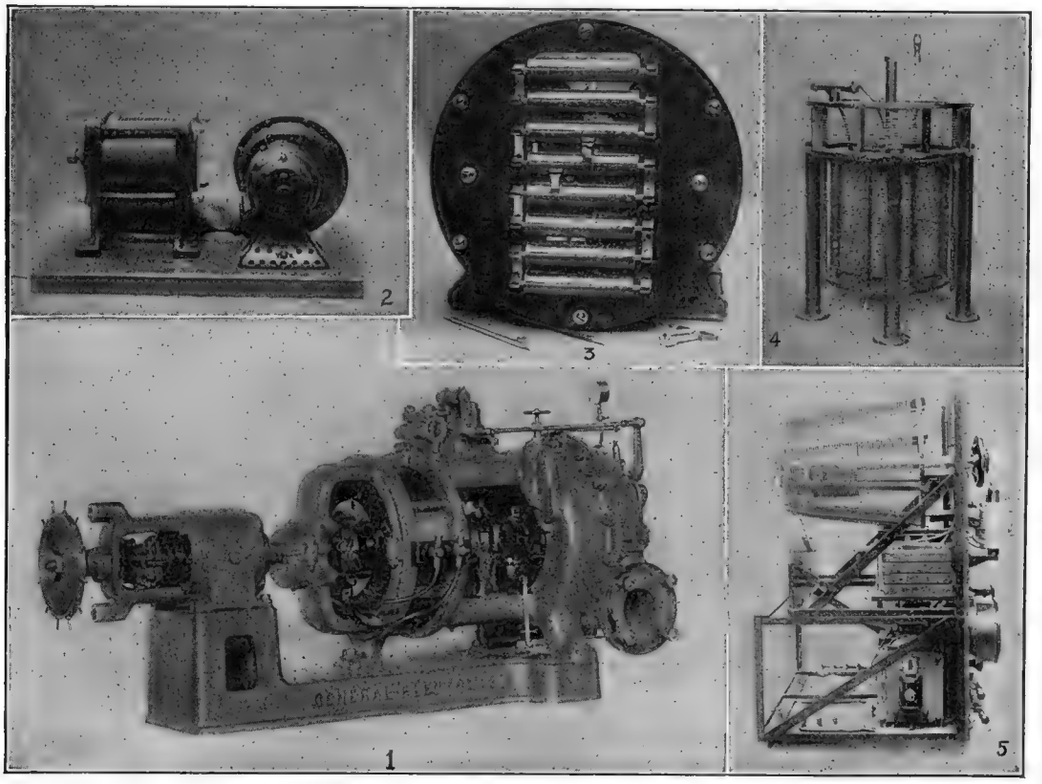


Fig. 6. Latest Military Radio Set Developed in Germany. It Comprises a Poulsen Arc Generator Together with All Necessary Tuning Inductances, Radiation Meter, etc.



Some of the Latest American Wireless Transmitting Apparatus.

Receiving Two Radio Messages on One Aerial

A dingy wire poked through the roof of a building at No. 206 Mercantile Place and emerging below through a sooty chimney kept Los Angeles in constant touch with the outside world during the recent storms when poles and wires were down and railroad traffic tied up.

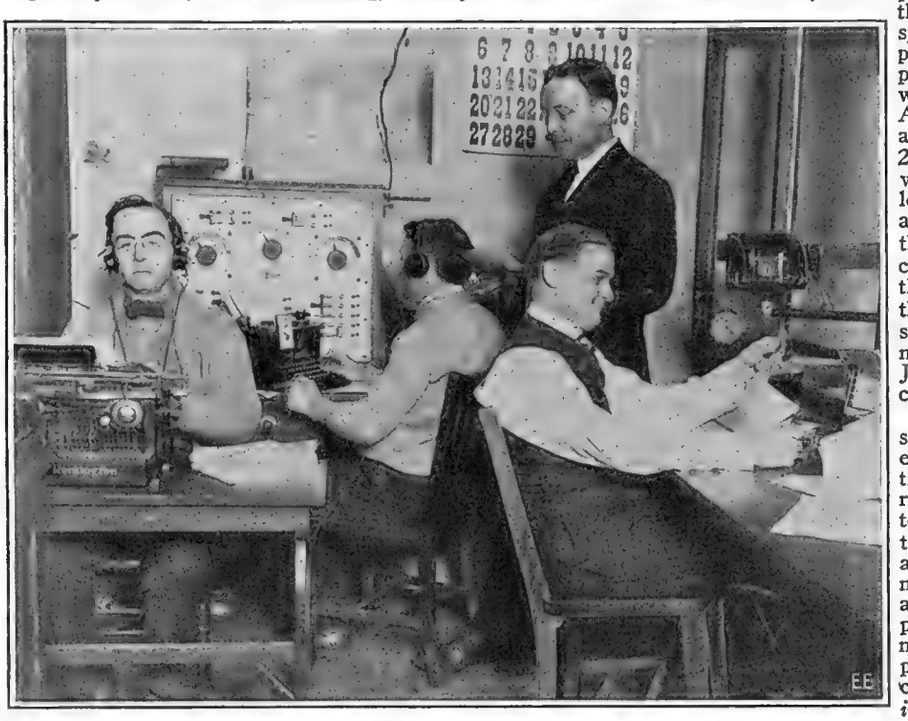
The wire was connected with the radio station of the Federal Telegraph Company at Twenty-third and Concord streets. In one day there were handled over it 900 telegrams and 6,000 words of press dispatches, said to be the greatest volume of commercial business ever handled in one day by any radio station in the world. In fact, according to A. Wakeman, local manager, the Los Angeles station regularly carries more commercial business than any other wireless station anywhere.

When communication with San Diego and other points was temporarily cut off, overwhelming demands were made on the wireless. John Laughlin McKinnon, wireless operator for the Federal Telegraph Company, conceived the idea of increasing the facilities of the one means of communication.

He strung a single wire from the antenna already in service and by means of an extra ultraudion was enabled to "tune in" San Diego and San Francisco on the one antenna, using the station at Twenty-third and Concord streets for transmitting.

Thus equipped it was possible for one man to send messages to San Francisco, another to receive from there and a third to receive from San Diego all at the same time.

The Federal company is working daily a wireless duplex system between Los Angeles and San Francisco, the only one of its kind in the world, sending and receiving simultaneously at high speed and using the continental code. This duplexing is accomplished by having each station sending on a different wave length, using two sets at the receiving station.



"Tuned In" on the Same Antenna. At the Left is John Laughlin McKinnon, Whose Ingenuity Added to Local Wireless Facilities During a Recent Storm. When the Photograph Was Taken He Was Receiving From San Diego. At the Same Time, H. L. Bleakney, Next to the Right, Was Receiving from San Francisco, and R. B. Black, at Right, Was Sending to San Francisco.

Mr. Wakeman in a recent statement said: "This scheme does not comprise, however, three receivers on one antenna, but it is, I believe, the first time in the history of wireless that the duplex has been made a commercial success. At the time the illustration here shown was taken, Mr. McKinnon was receiving from San Diego, Mr. Bleakney from San Francisco, while Mr. Black was sending to San Francisco. In other words, with the aid of the duplex, we were enabled to "copy" San Diego continuously without interrupting our 'duplex' to San Francisco.

"We have been working duplex with San Francisco since August 17, 1915, and while there has been no write-ups about this duplex, we who are working it daily, think it a wonderful thing. Using ultraudions, we have worked through the worst static conditions of this coast without any let up." Greater results are expected shortly.

NEW TELEGRAPH CODE.
All Dots—No Dashes.

Mr. Luis Jackson, of Montclair, N.J., formerly railroad industrial development commissioner, has invented an emergency telegraph code, the utility of which any one can grasp at sight.

This code is based upon the association of ideas, consecutive dots following the consecutive letters of the alphabet in contradistinction to the Morse code which is a series of uncorrelated arbitrary signs. He divides the alphabet into four grand divisions of six letters each, making twenty-four letters of the alphabet in consecutive order with a short fifth division for the two letters remaining, namely Y and Z.

Following is the code, which is made up entirely of dots and spaces—no dashes:

Group 1	A	B	C	D	E	F
	1|1	1|2	1|3	1|4	1|5	1|6
Group 2	G	H	I	J	K	L
	2|1	2|2	2|3	2|4	2|5	2|6
Group 3	M	N	O	P	Q	R
	3|1	3|2	3|3	3|4	3|5	3|6
Group 4	S	T	U	V	W	X
	4|1	4|2	4|3	4|4	4|5	4|6
Group 5	Y	Z				
	5|1	5|2				

Numbers	1	2	3	4	5	6	7	8	9	0
	1|	2|	3|	4|	5|	6|	7|	8|	9|	3|3

In the chart the number of the group is indicated by the first strokes and the number of a letter is indicated by the number of strokes following the space—the upright line indicating space. Thus, 1 stroke, space, 1 stroke, indicates A; 4 strokes, space, 5 strokes, W; 5 strokes, space, 2 strokes, Z, and so on. The ordinary code dash varies in length according to the individual operator, whereas the sound of the dot is direct and clear. His system is one of dots and spaces, eliminating dashes. As will be seen in the full code, A B C D E F form the first division. For a letter in this division the operator strikes 1 then pauses. This indicates that the operator is about to give one of the letters in group one. He then makes two strikes. 1, space and 2 strikes denotes the letter B; 2, space and 5 denotes K; 3, space and 4 denotes P; 4, space and 2 denotes T, while 5, space and 2 denotes Z.

He claims that one can become more conversant with his code in one hour than with a week's study of the Morse code, says *Telegraph and Telephone Age*. It requires about six months to become a fair operator in Morse. His idea is not to supersede the Morse code, but to place in the hands of the general public a system whereby every person can quickly express thought over wires or by sounds. After the code becomes a little known the call 2, space 6, associated with the twenty-six letters of the alphabet and repeated two or three times, will indicate to the receiver that there is a "ham" at the other end trying to say something and will mean "I am using the Jackson emergency code."

This code, Mr. Jackson claims, will, in emergencies, place the entire rank and file of a railroad, from president to brakeman, in a position to use the wires, and it will, he says, make every man in the army or navy a telegrapher in emergencies. It makes toy telegraph apparatus instructive and can be used by *amateurs in wireless communication* to their friends and by boy scouts in wig-wagging or for flash light signals.

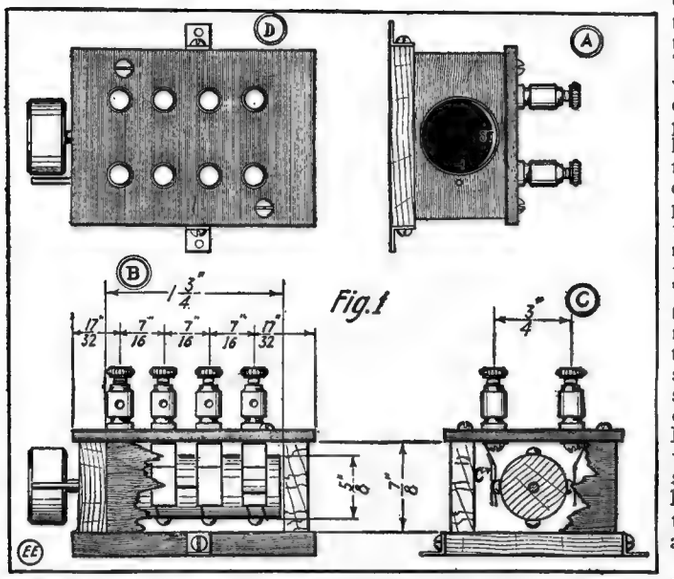
The number of dots and spaces should be written down as received and then translated. For underwater signaling, signaling by miners, mariners not acquainted with Morse who give flash light signals, heliographing and in a hundred other ways it can be useful as it places through its very simplicity the command of communication into the hands of the novice.

WIRELESS ON WYOMING RANCH.

Major James Ormsby is completing the installation of wireless telegraph plants at his home in Casper, Wyo., and at his ranch 50 miles to the northeast and when the system is in operation he intends to direct his large sheep business by wireless. The two plants are of sufficient power to receive messages from points up to 700 miles distant, and the lonely ranch, therefore, will be in constant touch with Denver, Omaha, Salt Lake and other cities of the region. The aerials of the Casper station are suspended from two poles, each 150 feet high. It seems as if there is no locality where wireless has not been utilized.

A Listening-in Switch for Radio Receptors

Many times the radio operator does not know when he is being "called," for his receiver is tuned to a higher wave length than that of the calling station. To listen in, yet fail to hear a call is disappointing, to say the least. By using the switch described in this article, however, such a disadvantage may be overcome. It will be noticed that with a *pair* of 'phones, signals are as easily read when one 'phone is disconnected as when both are in use in most cases except where long distance signals are not being received. In other words, the greatest advantage in a pair of 'phones is not that the signals can be heard in both ears, but that foreign noises can be more completely excluded. The purpose of this switch is to connect one 'phone to a *short wave, standby set,* and the other 'phone to a *long wave, tuned set,* or both 'phones to the latter. Ordinarily the switch is kept in the position marked ST on the handle. This means that *both* the standby and tuned sets are connected to the receivers. It is then possible to copy a station from either set, or, by revolving the switch, a station can be copied on the tuned set, using both receivers. A little experience in the use of this switch will quickly prove its value in operating the receiving apparatus.



Sectional View and Assembly of Listening-in Radio Receptor Switch, Throwing the 'Phones Onto Loose Coupler or Tuning Coil.

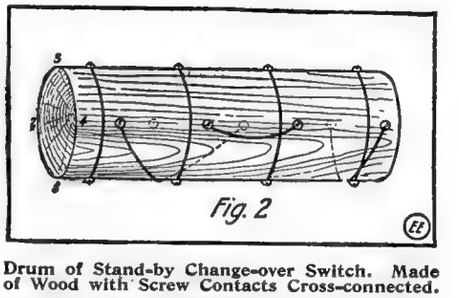
The drawings show four views of the switch. In Fig. 1, A is the front, B the side with part of the wood broken away, C the back, showing the cylinder and contacts, and D the top. The cylinder is of soft wood, ⅝ of an inch in diameter. The switch points are small, brass-headed upholstery tacks. In Fig. 2 the connections for the points are given. When the rows of points marked 2 and 4 are on the contacts, both 'phones are on the tuned set; when the rows 1 and 3 are on the contacts, both the standby and the tuned sets are in use. One of the contacts, C, Fig. 1, has a little bend which fits around the switch point. This keeps the cylinder in the right position against the contacts.

With this switch any receiving set may be used. However, the connections shown in Fig. 3 are the most satisfactory. The single slide tuner is about 3¾ inches in diameter, wound with 160 turns of No. 24 single silk-covered copper wire. This coil will tune up to 600 meters on a 200 meter antenna. The tuned set has a loose coupler and a variable condenser. The tuner has a primary 4 inches in diameter, wound with 250 turns of No. 26 single silk-covered wire on a tube 6 inches long. For the secondary, the coil is 3½ inches in diameter, wound with 250 turns of No. 28 single silk-covered wire, on a tube 5 inches long. A capacity of 0.001 mfds. is about right for the shunt condenser. If no condenser is used, the winding of the secondary should be increased to 300 turns.

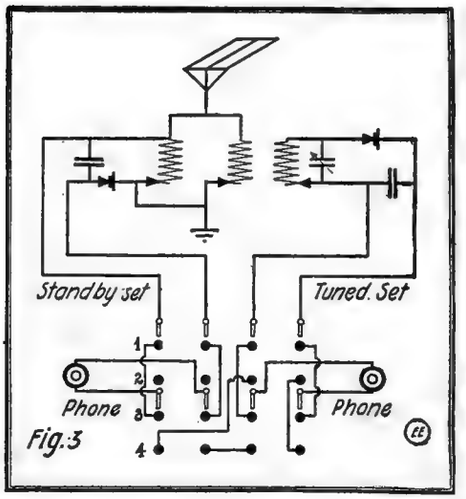
When listening in, the switch is put in the ST position, the single slide tuner adjusted to 200 meters (or any special wave length desired), while the adjustments of the tuned set are varied to pick up stations on the longer wave lengths. If a station is heard on the tuned set, it may be copied with one 'phone; the other 'phone will still bring in any stations which might call on 200 meters. When the signals are very faint, both receivers can be connected to the tuned set by changing the switch to the T position. If it is desired to copy a 200 meter station with both receivers the switch is changed to the T position and the wave length of the tuned set reduced.

A system of this kind can also be used for sharper turning. With the switch at ST, adjust the tuned set to the wave of the station wanted, and the standby set to the interfering station. This will make the interfering station louder in the standby 'phone, but fainter in the other. Now, by changing the switch to the T position, the interference will be eliminated or at least reduced, for the unwanted waves will pass through the standby set to the ground.

So many operators use two receiving sets for long and short wave lengths, that they should find in this switch an easy method of rapidly manipulating them.



Drum of Stand-by Change-over Switch. Made of Wood with Screw Contacts Cross-connected.



Connections for Broad Wave and Selective Tuning, Including Drum Switch

WIRELESS MESSAGES RELAYED BY TELEPHONE.

This experiment consists of sending radio messages over the regular telephone. This is accomplished by holding the wireless receiver tightly against the mouthpiece of the telephone. In most cases the receiving apparatus is located at some distance from the telephone, but this can be overcome by extending the receiver cord from the set to it. My radio outfit is upstairs so I ran some common twisted lamp cord out of the second floor window into a downstair window and thence to the telephone. By holding the radio receiver firmly to the mouthpiece and at the same time pulling out gently on the latter, the signals may be heard at the distant telephone receiver as loud as at the originating radio receiver. This affords a large field for further experiment. A wireless experimenter can call up a friend on the telephone and let him "listen in" on radiograms, or his jeweler (just before Arlington begins sending time signals) and thus allow him to regulate his clock accurately.

Contributed by WILLIAM A. CAWLEY.

EXPERIMENTER HINTS.

These hints will be found of benefit to the experimenter with but little cash to spend for his outfit.

Tuning coil slider rods can be constructed very nicely from old gas fixtures made from square brass tubing. Before using, however, remove the lacquer with a piece of rag soaked in alcohol.

Very good hard rubber switch knobs can be obtained from broken snap switches. The hole is not tapped for a standard thread, but can be easily retapped with a 6-32 tap. The round knobs are preferable.

Do not throw away blown fuses of the cartridge type. Remove the small pins which hold the brass caps in place. They can then be easily removed from the fiber tube. If the lead wires and the lugs are taken out by melting the solder with a torch, the brass caps make excellent detector cups. If the lugs are straightened out and connected with a short piece of wire a good battery connector is the result. The fiber tubes should be kept, as a variety of uses will present themselves sooner or later to the experimenter.

Contributed by DAVID MATHISON.

USEFUL DETECTOR HINTS.

Many times when a detector fails to work it is not the fault of the instrument, but of the owner. To overcome this fact the following hints will be found useful: 1. Never touch the mineral with your hands. 2. A light film of kerosene oil on the mineral will keep off dust. 3. A glass jar will be found useful to cover the detector with to prevent dust and other matter entering it. 4. To keep a good adjustment all that is necessary is some sealing wax. When the detector cat-whisker is on a sensitive spot and you can hear the signals in your receivers clear and loud, drop a small piece of sealing wax on the mineral and wire, and let it harden. The detector will prove more satisfactory if these hints are carried out.

High Spark Frequency in Radio-Telegraphy.

By Peter G. M. Clute

IT is certainly remarkable, in the light of recent reasearches to increase the working range of radio-telegraphy, that so little attention has been paid to the advantage of high spark frequency. One apparent cause of this neglect is the unfounded, though wide-spread, belief among students and commercial workers in wireless telegraphy that the newer and recent types of high-resistance telephones, such as they generally employ, do not exhibit any great change of sensitiveness with variations in the frequency.

Practically all long-distance receivers used for radio-telegraphy make use of the telephone for the reception of signals. And any thing or circumstance which increases or decreases the sensitiveness of the telephone, increases or decreases in the same proportion, the sensitiveness of the receiving apparatus. A great number of scientific observers, among whom are Wein and Lord Rayleigh, have noted that the telephone is more sensitive for high than for low frequencies. Since they, as far as possible, made use of waves of sinusoidal form (sine waves), free from overtones which impart serious errors to experiments of this kind, their experimental results are full of interest and of particular value.

Wien's observations for a Siemen's telephone having a resistance of 187 ohms, were as follows:

Frequency.....	64	128	256	512	1024	1500	2400	4000
Current to produce audible sound—10^{-8} amperes....	1800	220	26	1.7	3.0	6.0	2.0	50

Lord Rayleigh's results were made on an ordinary type of telephone of 70 ohms resistance. His results are given below:

Frequency.....	128	192	256	320	512	640	768
Current to produce audible sound—10^{-8} amperes.....	2800	250	83	32	7	4.4	10

These results show a rapid increase up to a frequency of nearly 500 cycles per second, above which the change is slight.

With these investigations in mind, the U.S. Bureau of Standards has carried out a similar investigation on telephones of the type now used in radio-telegraphy. For the purpose a pair of head telephones of about 800-ohms resistance was taken. The Bureau has a set of dynamos in its laboratory ranging in frequency from 60-900 cycles per second and giving nearly pure sine waves, as free from overtones as possible. A current of from 80 to 100 milliamperes was measured on a very sensitive hot-wire instrument and was then shunted thru non-inductive shunts so as to cause sufficiently small fall of potential over a slide wire of known resistance; from this the requisite E. M. F. to just produce an audible sound in the telephone was taken.

The results of this experiment are shown in tabular form, as follows:

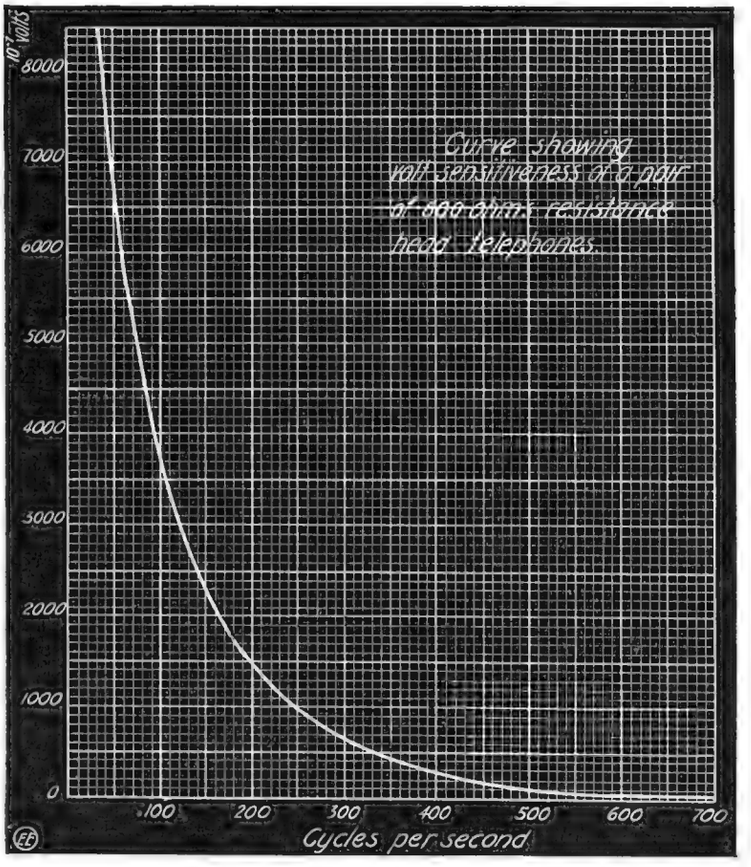
Frequency (Cycles per sec.)		Least audible voltage (10-7 volts)
(FROM CURVE)	50	7000
BY EXPERIMENT	60	6200
" "	100	3700
" "	150	2240
" "	180	1700
" "	200	1450
" "	250	980
" "	300	600
" "	400	200
" "	500	100
" "	600	60
" "	660	30
" "	700	28
" "	900	6

Curve I gives the graphical representation of these results, and it will be seen that between 60 and 900 cycles the change in volt sensitiveness is over one thousand times.

When comparing these results with those given before it will be seen that the change in sensitiveness is of the same general type, with the exception that the flat portion of the curve begins at a somewhat higher frequency.

If we consider these results in their bearing on radio-telegraphy, it appears that by increasing the spark frequency at the sending station, we can increase many hundred times the effective sensitiveness of the receiving station. This condition can be obtained, in addition, without the expediency of increasing the sensitiveness of the wireless receiver itself. An additional advantage is pointed out in utilizing a high-pitched musical spark, in that the ear picks out such signals with ease in the midst of ordinary interference and atmospheric disturbances.

In boosting the spark frequency the energy of the spark is, of course, reduced, which is of a disadvantage in cases where a receiver of the recording coherer type is used, but experiment shows this reduction in energy per spark to be far more than counterbalanced by the increased sensitiveness of the receiving apparatus, where the telephone is used.



Graphical Representation of Volt-Sensitiveness for a Pair of 800 Ohm Wireless Receivers at Various Frequencies. As the Frequency Increases the Volts Required to Give an Audible Signal in the 'Phones Decrease.

Another distinct advantage is gained by spreading a given amount of energy over several sparks instead of concentrating it into one, in that the potential differences are reduced, resulting in a reduction of condenser losses, which in the average radio station amount to a considerable part of the total power.

It has also been shown that an increase in spark frequency, produced by shortening the spark gap and thus making use of the partial discharges which are usually considered so detrimental, causes a several fold increase in the loudness of the signals without any increase in power consumed.

The question of cooling the spark gap can be settled by means of some type of rotary spark gap. The wheel is rotated rapidly by an independent motor without regard to synchronism with the alternator, the current being conveyed to the wheel by means of brushes. The face of the stationary member of the gap should form the arc of a circle, long enough to a little more than cover the distance between two spokes of the wheel, thus always insuring the proper sparking distance. The rotating wheel itself forms an efficient fan.

MARCONI'S NEW RADIO DISCOVERY.

Signor Marconi has been engaged in research work in Italy, where he has been able to carry out some important experiments and tests. He advises that the results obtained are far-reaching and directly concern the future practice of the entire science of wireless telegraphy and telephony over both long or short distances, no matter whether conducted by means of ordinary sparks, quenched sparks, or continuous waves.

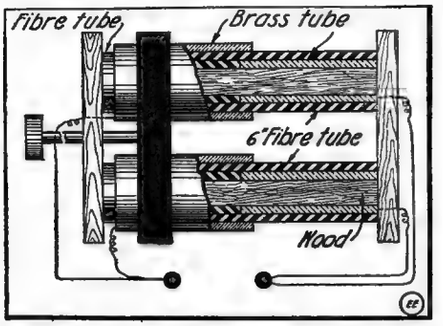
He is now engaged in making applications for patents which probably will be applied at once in Italy to military purposes. By these means results heretofore impossible will be obtained.

WIRELESS TO READ MIND.

Can thoughts be read? Walter W. Massie, an eminent radio scientist, declares that recent wireless experiments have led him to believe that in a few years we actually may be able to read men's thoughts. He maintains that within a few years we will be able scientifically to read the innermost thoughts of mankind it is said.

A PRECISION VARIABLE CONDENSER.

I will try to describe a real good variable condenser: Get a piece of wooden rod ⅜ inch in diameter and 12 inches long, cut in half and slide a piece of brass tubing 3



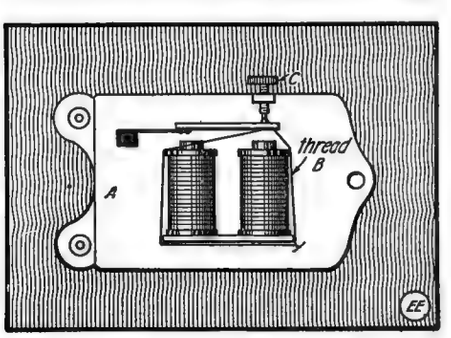
Commercial Type Tubular Variable Condenser for Receiving Circuits.

inches long, ½ inch outside diameter, over it. Such tubular pieces should be placed on the end of each wooden rod. Next obtain a piece of fiber tubing 6 inches long and the same diameter; cut up into two pieces and slide on the opposite ends of the rods. Now get two pieces of fiber tubing ½ inch inside diameter and ⅝ inch outside diameter, each 6 inches long, and slide over the rod. Procure some mahogany ½ inch thick and make one piece 7½x4x½ inches, two pieces 3x2x½ inches and one piece 3x1x½ inches. Bore a hole in the two pieces 1 inch down, ½ inch in and ¼ inch deep in the ends of the 3x2x½ inch pieces, i. e., two holes to a piece, big enough to accept the rods. Get two pieces of brass tubing 3 inches long and ⅝ inch outside diameter and join the two pieces with a 3x1x½-inch piece of wood so that they slide along the two rods. Now mount the end pieces on the base. Make a suitable handle and place on a piece of brass rod ⅛x4 inches. Pass the other end through a hole in the wooden end and into the mahogany block connecting the two sliding tubes. Connect the stationary tubes to a binding post and the movable ones to another binding post by flexible cord, or contact may be established through the ⅛-inch control rod. To vary the capacity slide the tubes up and down the rods. This form of condenser, although having a low capacity, is extremely serviceable for fine tuning, such as in audion detector circuits, etc.

Contributed by
AN EXPERIMENTER.

AN IMPROVED BUZZER TEST.

As is well known by all wireless dabblers, a buzzer test is indispensable for test-



Method of Silencing Test Buzzer.

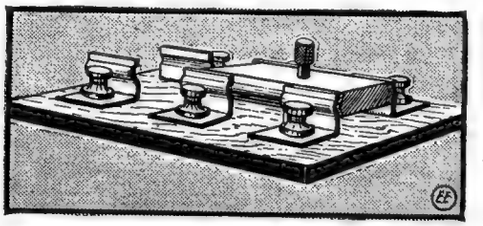
ing out the detector. But with the ordinary buzzer the noise given off drowns out the sound in the 'phones. With this new idea, a buzzer can be hung under the operating table and can scarcely be heard. It can be made to give a very high pitch tone, resembling the high power government stations. As will be seen in the diagram, A is an ordinary buzzer around the armature of which is tied a piece of thread B. By loosening the contact screw C the tone can be adjusted to any pitch.

Contributed by C. E. MIELKE.

IMPROVED RADIO SWITCHES.

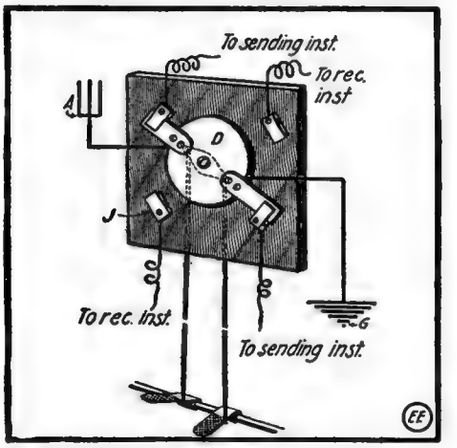
I show two sketches herewith of easily made switches, suitable for wireless stations or other purposes and the materials for constructing which are found around most experimenters' laboratories.

The first switch consists of six spring brass or copper jaws and between these, arranged to slide back and forth, is a fiber or hard rubber block. This block has a switch handle on top of it, as observed, and on either side of the block there is secured by small wooden screws two copper or brass shoes. The moving block, when slid from right to left, or vice versa, affects the action, as will be perceived.



Sliding Switch Design for the Amateur.

The second switch of my design is of the rotary type; also this is very quick in action and highly adaptable to foot control by means of two treadles, as drawing



A Foot-Controlled Aerial Switch for Radio Stations.

shows. The copper or brass blades on the rotatable drum D make contact with regular metal jaws J. Current is conducted to the moving blades on drum D by flexible leads or otherwise.

Contributed by R. L. KUNAN.

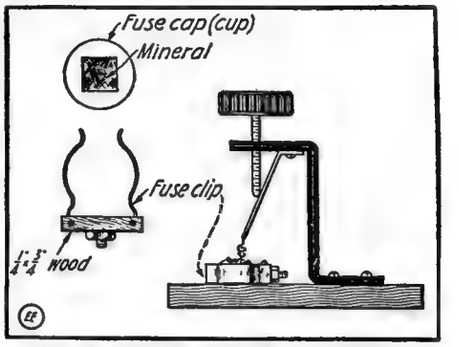
DOES AWAY WITH RADIO TOWERS.

A wireless telegraph invention eliminating the present towering steel structures for sending and receiving by simply projecting a short wire along the ground was announced at San Francisco recently by R. I. Woolverton, U. S. radio inspector at that port.

UTILIZING FUSE PARTS IN A DETECTOR.

A good detector cup is easily made from a cartridge fuse cap. By using a fuse clip, as shown in the illustration, a number of cups can be used, which may be slipped in and out in a few seconds.

The upright block to hold the clip may be of wood (although hard rubber was used by the author) and should be carefully drilled with two holes on top and



Use of Fuse Cap and Clip on Detector.

one in the center. If the base is of hard rubber two more holes must be drilled in the rubber and it is then fastened with machine screws and nuts. The clip is also attached with a small machine screw and nut. This is about one of the easiest, handiest and cheapest detector cups and receptacles that I have seen.

Contributed by FRANK TALONE.

A FEW WIRELESS WRINKLES

To drill glass use a solution of turpentine and gum camphor. Apply this to the glass as drilling is done. Use a metal drill.

Tuning coil tubes can be made of bristol-board. This is a light-weight cardboard and can be purchased at any stationery or drug store. The cylinders are made by gluing the several pieces of the board around each other.

Small strips of brass drilled and tapped for several small bolts are very handy for aerial connections. They can be taken from discarded rosettes and other electrical fittings.

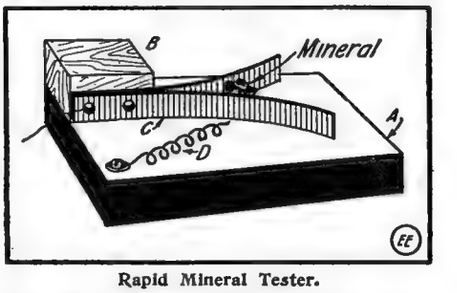
Discarded heating elements from electric stoves make good rheostats for wireless transformers. The different resistance wires should be connected in series to obtain the greatest resistance, and on parallel for high current capacity.

Contributed by PAUL DAY.

MINERAL TESTING STAND.

The following is a device with which the sensitive spots on a crystal can be quickly found, and should prove useful indeed to the amateur.

The base A is a piece of wood 2x3x½ inches, on which is screwed a block B measuring 1x¾x⅜ inch. C is a strip of brass or other springy metal 5 inches long and ¼ inch wide bent as shown. The crystal is slid in between the ends of C and



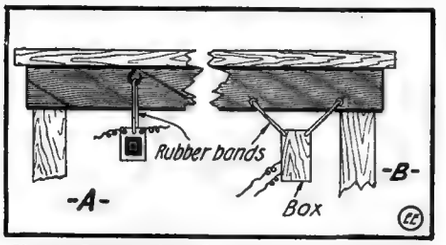
Rapid Mineral Tester.

searched for a sensitive spot with the fine wire D while the buzzer is operated. In this manner a crystal can be tested before mounting in detector, saving much time and trouble.

Contributed by
WILMER J. SLIFER.

ELIMINATING NOISE FROM TEST BUZZER.

Many radio operators using a test buzzer on their receiving sets are undoubtedly troubled by the constant noise produced by same. A very simple way in which to eliminate this is as follows:



How to Suspend Test Buzzer So As to Eliminate Noise.

Suspend the buzzer from a screw-eye (see A in figure) by means of four or five rubber bands twisted together. Make the ordinary connections and use in the regular manner. If further noise curtailment is desired suspend a small box by means of rubber bands, and after the buzzer has been installed inside pack cotton loosely around the same (see B in figure). This will give the most satisfactory results.

Contributed by ALLEN SJOHOLM.

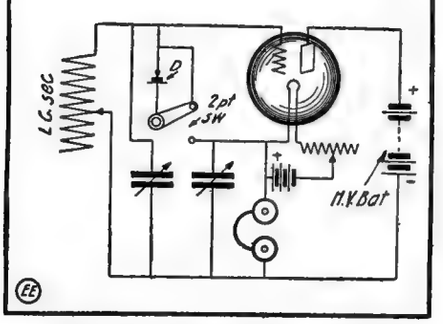
TELEPHONE MESSAGE HEARD ON RADIO SET.

On the evening of Feb. 2 I had a novel experience which I think would be of interest to other "Buglets" (I get the name from *The Experimenter*). I was "listening in" at my wireless set when I was surprised to hear the voice of a young lady in the receiver. I naturally thought that one of the *Martian belles* was tinkering with *Baron Münchhausen's wireless telephone!* I presently discovered, however, that my brother was talking to a young lady over the telephone. The telephone wire is located in close proximity to my aerial. I suppose the electrical currents passed through the intervening air to the aerial by induction. When I moved my slider along the tuning coil it had no effect on the voice. I told my brother to ask the lady to shout into the 'phone. When she did this I could make out everything she said.

Contributed by FRANCIS J. CONNELLY.

HOOK-UP FOR USING D. P. S. T. SWITCH IN RECEIVING CIRCUTS

In the ordinary arrangement of wireless receiving circuits employing a mineral and also an audion detector it is the general practise to use a D. P. D. T. switch to



Quick "Change-Over" Switch for Using Audion or Mineral Detector.

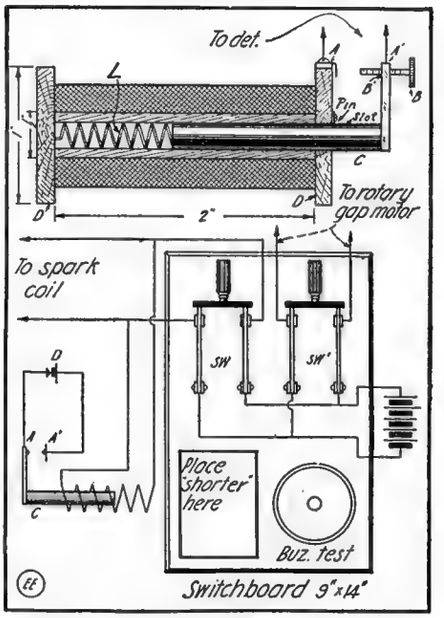
change from mineral to audion detector, or vice versa. It is also customary to short-circuit the mineral detector, especially galena, while transmitting to prevent the burning out of the sensitive point on the mineral. This, also, necessitates another switch.

By employing the connections as shown in the illustration herewith a D. P. S. T. switch is all that is necessary. This can be accomplished with a single throw of the switch lever. As the filament and high voltage telephone battery are open while using the mineral, there will be no loss of energy by portions of the audion circuit remaining connected. The presence of the telephones in the "common wire" tends to increase the signal strength when using the audion, and when utilizing the mineral the telephones are connected as usual across the condenser. The telephone condenser should be variable for best results, whether the mineral or audion is used.

Contributed by FRANK J. COLLINS.

DETECTOR "SHORTER" AND SWITCH-BOARD.

The accompanying illustration shows a relay for "shorting" the detector while transmitting, together with a small switch-board to control various apparata.



Magnetic "Shorter" for Detector Circuits.

The relay is made by winding five layers of No. 20 enameled magnet wire on a wooden spool, D, of the dimensions and shape as in the drawings; a soft iron bar, C, forms the core; this is three-eighths of an inch shorter than the drum and should fit a little loose in the "core way," which is one-quarter of an inch in diameter, and is fastened with a spring, L, at the inner end of the spool, in order to push it about half way out. A and A' are the two contact points of copper or brass; B is made of the same metal and fastened to the core. It is drilled and tapped at B' to fit the set screw A'. It may be seen that when the circuit is closed the bar is drawn in by the solenoid and contacts A and A' are closed.

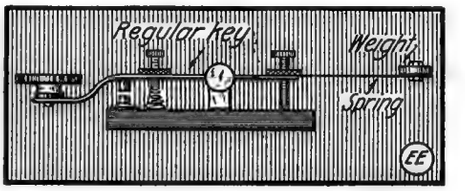
On the switchboard are mounted two D.P.S.T. switches, one for the rotary gap, the other for the spark coil current and "shorter"; the latter is placed where indicated; to the right of it is placed the buzzer-test push button. It would be a good plan to place the buzzer in a box about six inches square, muffled in cotton and placed in back of the switchboard. The board is mounted on the operating table with two angle irons.

Contributed by STEPHEN F. CSOHAR.

HIGH SPEED KEY ATTACHMENT.

With this attachment most any key can be made into a high-speed key, so much wished for by the advanced radio or telegraphic amateur.

As will be seen from the drawing, a piece of spring steel about 3 inches long is fastened to the key at one end, while the



Simple Speed Key Attachment.

other end has a small lead weight attached. While sending the lead weight is tapped with the left hand, and by a slight pressure on the key knob the vibration of the weight makes the dots very rapidly.

Contributed by C. E. MIELKE.

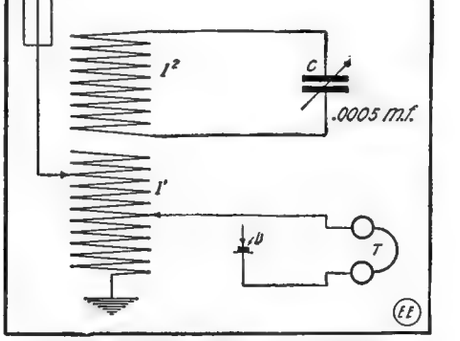
WHEN A STORAGE BATTERY IS SAID TO FLOAT ON THE LINE.

A storage battery is said to float on the line when it is connected across the mains at some distance from the power station, so that a heavy load on the line within the range of the battery influence, causes sufficient drop in the line to allow the battery to discharge. With a light load on the line, on the contrary, the drop is small, and the impressed voltage at the battery is high enough to send a charge into the battery. The floating of batteries on the line is confined usually to electric railway service, where there is a large variation in line voltage. It boosts the electrical pressure when it falls, due to intermittent abnormal load.

NEW HOOK-UP FOR UNDAMPED OSCILLATIONS.

Most amateurs believe that they must have an oscillating audion, etc., to receive undamped waves. In this article I will endeavor to show how to receive undamped waves without an audion or the bothersome, inefficient tikker.

Referring to the diagram, "C" is small condenser (variable), for instance; I^1 is a cardboard tube 32 inches long by 5½ inches in diameter, wound with one layer No. 30 S.S.C. copper wire; I^2 is 32 inches long by 5 inches in diameter. This circuit should tune about 8,000 meters with the average aerial. Only the turns on a small part of both coils should be tapped off, as this circuit cannot be used on wave-lengths under 7,000 meters. The detector should



Circuit for Producing "Beats" in Receiving Undamped Wave Signals.

be perikon or silicon for best results. This hook-up is intended only for amateur use, as it is patented.

Contributed by FRANCIS R. PRAY.

THE CONSTRUCTOR

Water Wheel Drives for Private Lighting Plants

By H. Winfield Secor.

PART I.
DESIGN AND CONSTRUCTION OF WATER WHEELS.

THOSE fortunate individuals who are so blessed as to have on their premises a source of water power, be it a full-grown lake, or simply a trickling brook, have at their command all the conveniences that electricity can afford. These include, primarily, electric lights and the usual adaptations such as electric stoves, water heaters, etc., etc. Secondly, there is that large field of usefulness always open in rural localities, as for instance the adoption of electric motor drive for the various operations of grinding corn, wheat threshing, ensilage cutting, pumping water, churning the butter, milking (by the vacuum process), cutting cord wood, washing the clothes—ad infinitum.

The first important consideration will be to ascertain how many pounds or cubic feet of water are available from the stream or lake in a given time. It is best to make a number of measurements in this direction during the *dry* and *wet seasons,* preparatory to any definite planning. Data and formulae will be given in Part II, covering the electrical calculations, and for most cases of amateur hydro-electric propaganda the governing fact will usually be —not how many kilowatts do I want? (1K.W. is equivalent to 1⅓ horsepower)—but how many kilowatts will my lake or brook give me?

For our better guidance it is perhaps best that we know in a general way about how much water is required to supply a certain amount of horse-power. Fig. 5 will help us to gain this information. Note the characteristic curve for the 12 inch standard turbine wheel (costing about $90). This turbine consumes a stream of water of 18 square inches cross-section, and the cu. ft. discharge (and conjointly, the amount taken in) per minute, is noted by observing at what point on the curve, A, the *water head in feet* horizontal lines, and *cu. ft. water discharged per minute* vertical lines meet. For example, with a 6 ft. head the 12″ turbine consumes 147 cu. ft. water per minute and develops 1.25 H.P. (see H.P. equivalents for different heads at base of chart, also revolutions per min-

Photo from H. E. Zimmerman

Fig. 1. A Home-Made Water Wheel of the Over-Shot Type Which Drives a Dynamo, a Washing Machine and Other Apparatus. It Was Built at Small Expense by a Genius of Woronoco, Mass.

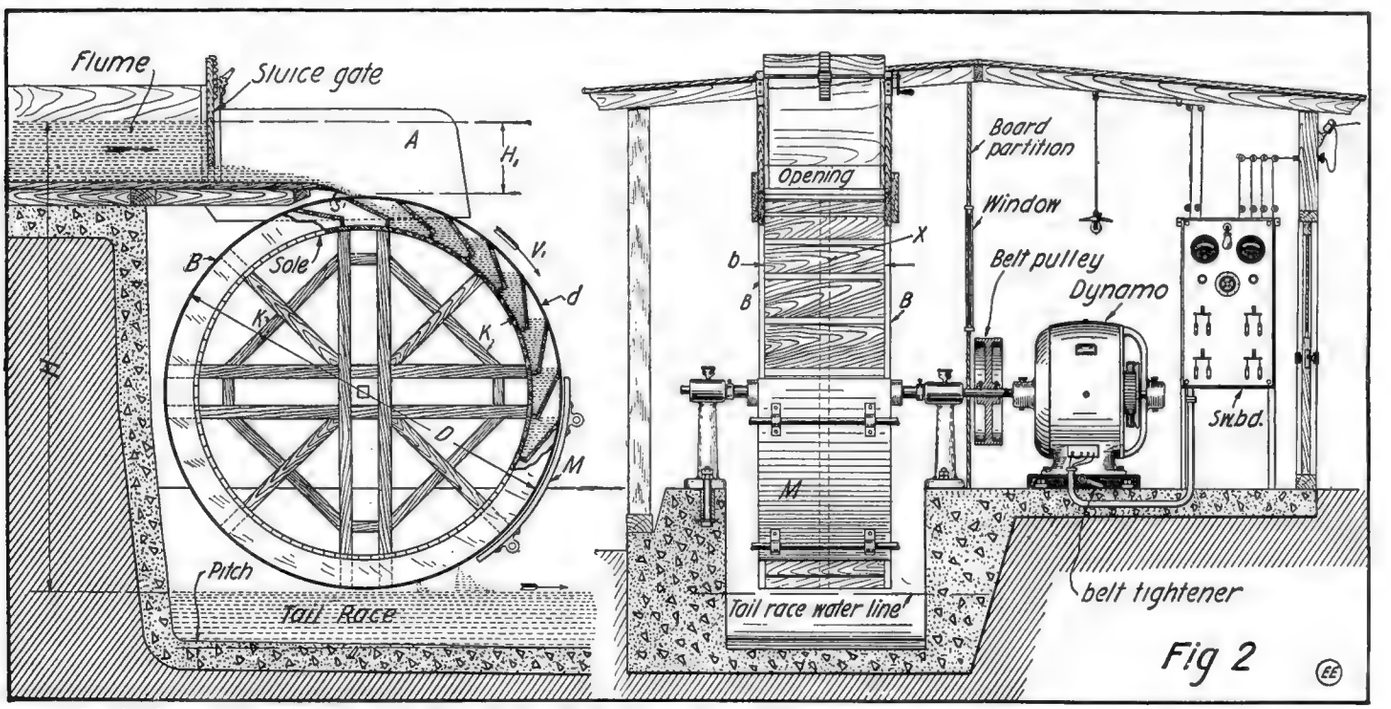


Fig. 2. General Arrangement of an Over-Shot Wooden Bucket Water Wheel, Including Suggestion for Dynamo and Switch-Board House.

ute—R.P.M.). Curve B enables us to find the speed of the turbine wheel at any head in feet, also the horse-power at various heads. The head in feet means the height of water (or the equivalent head or height, as for instance that gained by velocity) above the turbine or wheel. Every foot of head produces a static pressure of .434 lbs. per sq. inch at the base of the

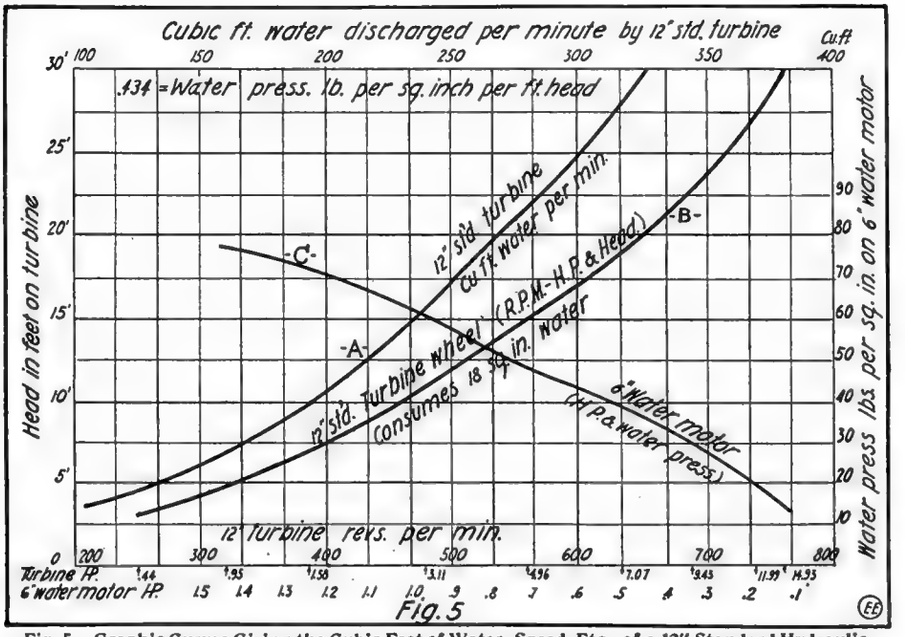

Cubic ft. water discharged per minute by 12" std. turbine
Cu.ft
.434 = Water press. lb. per sq. inch per ft. head
Head in feet on turbine
Water press lbs. per sq. in. on 6" water motor
12" Std. turbine
Cu. ft. water per min.
-B-
-C-
-A-
12" Std. Turbine wheel (R.P.M.-H.P. & Head)
consumes 18 sq. in. water
6" Water motor
(H.P. & water press.)
12" turbine revs. per min.
Turbine HP.
6" water motor HP.
Fig. 5

Fig. 5. Graphic Curves Giving the Cubic Feet of Water, Speed, Etc., of a 12" Standard Hydraulic Multiple-Vane Turbine and a Common 6" Water Motor.

water column. The relation then between *water head* and *water pressure* is at once apparent.

Now referring to curve Fig. 5—C, the characteristics of a 6 inch water motor (Hercules and other types), such as used for grinding, driving small dynamos, etc., are perceived. These indicate that with a fairly high pressure the 6" water motor, although of slight initial cost, is capable of producing considerable power. At a pressure of about 78 lbs. (at left of chart) the H.P. abscissa lines intersect curve C, at a value of 1.45 H.P. The cu. ft. of water consumed per minute (measure for one-fourth minute and multiply quantity by four) by any turbine or motor, is readily ascertained by discharging the efflux into a tank of known dimensions. Sometimes it is weighed and the cu. ft. then calculated, allowing 62½ lbs. per cubic foot.

The efficiency of the turbine, as well as that of the water motor, is high. It averages 85 to 90 per cent. with fairly high heads.

Coming to the subject of *water wheels,* similar to the type illustrated at Fig. 1, known as the *over-shot wheel,* the overall efficiency averages 70 to 75 per cent., depending upon the operating conditions, workmanship, etc. For home-made wheels (the over-shot type only is here considered, it being more efficient than the breast or under-shot wheels, which have fallen into disfavor), the efficiency of conversion of the theoretical horse-power of the water, to that developed at the wheel shaft for driving dynamos or other machinery, may be assumed at 70 per cent. On this assumption there will be required for each horse-power 704 cu. ft. water falling over the dam or sluiceway per minute, through a 1 ft. head. This includes 30 per cent. loss in the wheel. The quantity of water required per minute with one foot head is:

$$Q = \frac{33{,}000 \times \text{H. P.}}{.70 \times 62.5}$$

where:

Q=Cu. ft. water required per minute through one foot head.

H.P.=Horse-power desired.

Naturally as the head increases, the quantity of water required per minute decreases. This is evident from the formula for the H.P. of an over-shot water wheel:

$$\text{H. P.} = \frac{\text{H. F} \times \text{W.}}{33{,}000} \times .70$$

In which:—H.F.=Head in feet from level of tail-race to the top of flume water surface.

W=Weight water falling in lbs. per minute.

Having digested these rudimentary laws of hydro-mechanics, the next problem is to determine the quantity of water available per minute, as becomes evident from a perusal of the foregoing. This problem may be tackled in several ways. Space does not here permit of going into the matter in full detail, but a few figures will be cited enabling those interested to gain the general idea of procedure at least.*

It is quite evident that the volume of water in cu. ft. flowing past a given point per second is equivalent to its velocity in feet per second, multiplied by the cross-sectional area of the stream at that point, or by the area of the *wet-perimeter,* as it is termed. Hence, if we place a wood float, consisting of a round stick weighted at its base so as to just clear stones, etc., in the stream and time its travel between two fixed points, it is then a relatively simple matter to readily calculate the approximate velocity of the water current. A common value for streams is 6 to 15 second-feet; meaning that the float when timed traversed a distance of 6 feet, say in one second.

Several such *timing tests* should be conducted at different seasons, and an average of the lot taken as a criterion, upon which to base further computations. In some cases it is considered good practice to accept the minimum velocity as the working factor. The current velocity having thus been found, the volume in cu. ft. of water flowing per second is ascertained by multiplying the mean velocity in feet by the average width and depth of the stream or lake at the section timed; i.e., the feet per second times the sq. ft. of cross-sectional area.

The mean velocity as observed by a rod float (of wood or hollow tin) is to be considered as the actual mean velocity only when the float is made to pass *close to the bed of the stream.*

(*Continued on page 210*)

**For further details on the measurement of bodies of water, and the available horse-power, see the following:*

Civil Engineer's Handbook—International Textbook Co.

Vol. 98, Water Wheels and Hydraulic Machinery—International Textbook Co.

Mechanical Engineer's Handbook—Kent.

Turbine Water-Wheel Tests and Power Tables—by Robert E. Horton—Published by the Government Printing Office, Washington, D.C., who also supply a bulletin on Methods of Stream Measurements.

How to Use Water Power—by Herbert Chatley.

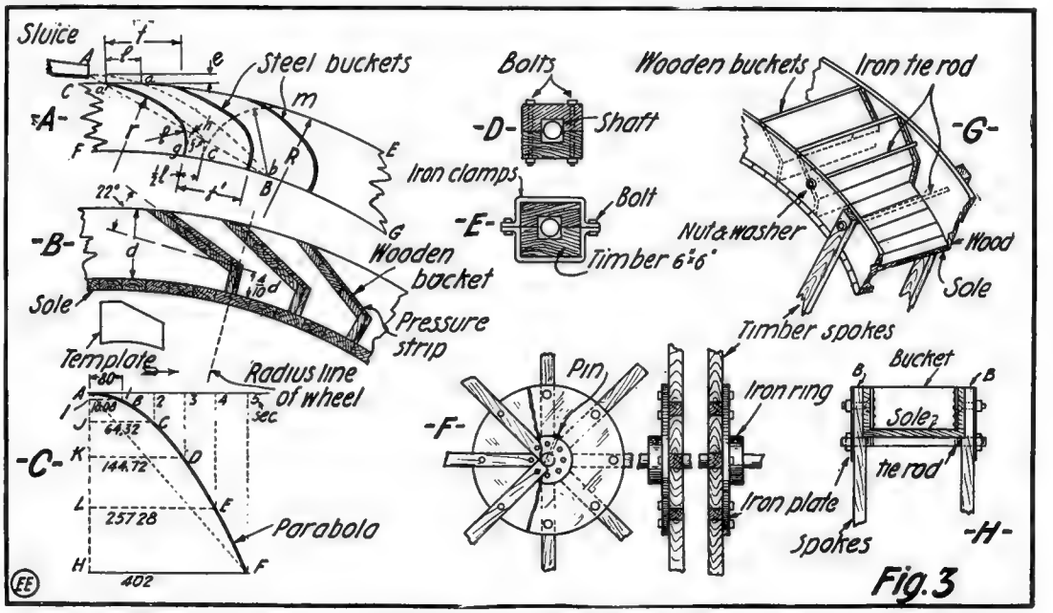


Fig. 3. Details for Laying Out Iron and Wooden Buckets of Water Wheel. Also How Spokes and Axle May be Arranged in a Substantial Manner.

The Construction and Use of the Gold-Leaf Electroscope

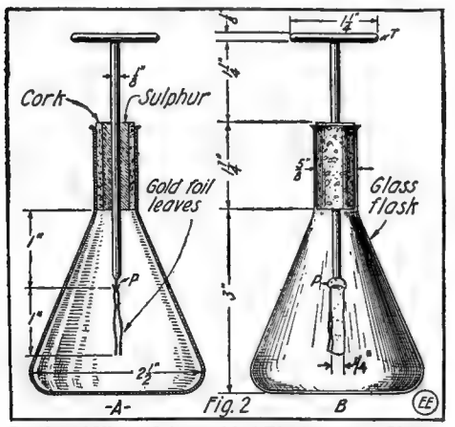
By E. H. Johnson

[Editor's Note.—*For an unknown reason our modern electrical experimenters do not use the gold-leaf electroscope, as much as they ought to. It is an eminently practical instrument, with which hundreds of interesting as well as important experiments can be performed. Moreover, it is exceedingly simple to make and can be built at a very small cost. Who will be the first experimenter to find a practical use for the gold-leaf electroscope in wireless? Remember, it is a very sensitive instrument. Read Mr. Johnson's article by all means.*]

ANY device that serves to indicate the presence of an electric charge without necessarily showing the magnitude of the charge may be called an "electroscope." Thus bits of paper that are attracted by a rubber comb are electroscopes, in that they serve to show the presence of an electrification on the comb. All such indicators are, of course, of interest, but otherwise are perfectly useless because owing to their nature they are entirely uncontrollable. Those experimenting with electric charges need not only a means of showing the presence of such charges, but one that will tell whether the charge is *positive* or *negative*, and at the same time afford an *approximate measure of the quantity of the charge* that it is being dealt with. These requirements are all met by the gold-leaf electroscope, which has the general appearance shown in the accompanying illustrations and may be constructed as described below. If reasonable care is used this instrument, though exceedingly simple, will give perfect satisfaction.

First procure a chemical bottle or flask about 4 or 5 inches high, of which the inside diameter of the neck is not less than ¾inch. Wash this bottle very carefully with alcohol, for any dust or streaks of dirt which remain in the bottle will cause trouble, because they will make the surface of the glass a conductor and the electroscope will not retain a charge. In Fig. 1 and 2 the bottle shown is an ordinary Erlenmeyer flask (procurable from your local drug dealer or chemical and glass supply house), which has the advantage over an ordinary bottle in being made of thin, strong glass which is light and at the same time very neat in appearance. However, any bottle will serve practically as well.

Next, from sheet brass ⅛ inch thick cut a circular disc 1¼ inches in diameter. This is for the top of the electroscope T. (Fig. 2.) The edges should be very carefully filed off, rounded and polished, so that



Sectional View of Assembled Electroscope, Showing Cork and Sulphur Support of Metal Stem.

there may not be even the suggestion of a sharp corner or projection on the disc anywhere. Now procure a piece of brass rod ⅛ inch in diameter and 3½ inches long. Solder this wire to the center of the brass disc so that it is perpendicular to the face of the disc. The other end of the wire should either be flattened or soldered to a small piece of sheet brass P of the shape shown in the illustration and not much

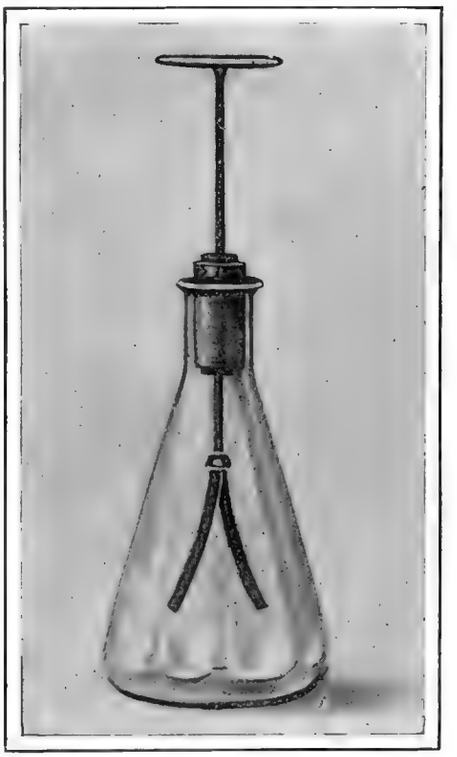


Fig. 1. Appearance of Highly Sensitive Gold-leaf Electroscope Capable of Being Made by any Experimenter. An Extremely Slight Electric Charge Will Cause Its Leaves to Diverge; Also It Will Indicate the Polarity and Quantity of the Charge.

thicker than an ordinary sheet of paper. This is to support the *goldfoil* leaves so that they may lie very close together.

Now take a good cork that fits snugly in the neck of the bottle chosen for the electroscope and make a hole through it lengthwise the size of a pencil or larger. With a very sharp knife or, better, with a round file enlarge this hole until the remaining wall of the cork is about ⅛ inch thick. Pass the rod through the opening in the cork so that it lies accurately along the axis of the cork and projects about equally from each end. Melt some sulphur and when it first becomes liquid enough to pour easily fill the space between the cork and the rod. Only pure sulphur should be used and care should be taken that it does not burn in the melting. It is to furnish the insulation for the electroscope, and if it is scorched or impure the insulation will be imperfect.

The metal part of the instrument may now be lacquered with shellac made very thin by adding much alcohol to it. The little metal plate P at the bottom of the wire should be left unvarnished. Cut two strips of goldfoil each ¼ inch wide and from 1 to 1½ inches long. Any sign-painter from whom the foil may be obtained will be glad to demonstrate the method of handling and cutting it. If goldfoil cannot be obtained* Dutch metal foil or aluminum foil will serve almost as well. Of course anything like tinfoil is far too heavy.

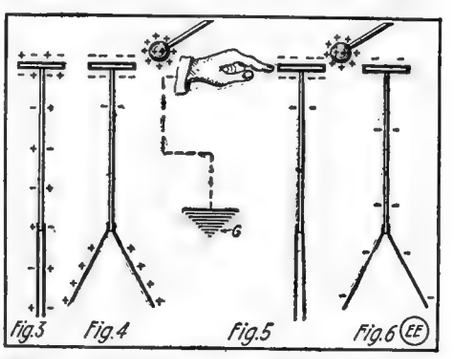
Moisten the faces of the flattened end of the wire P with a very little bit of shellac, paste or white of egg and attach the foil leaves so that they will be suspended, hanging very close together.

The bottle should now be warmed slightly, so as to be very dry, and the cork placed in its neck. Care should be taken at all times not to rub the fingers over the surface of the sulphur plug, for if this surface becomes soiled the charges will leak away.

The instrument proper is now complete and all that need be added to the outfit before proceeding with experimental work is a *proof plane*. This is simply a piece of smooth metal attached to the end of a rod of insulated material as a handle, and it is used to carry charges of electricity to and from the electroscope disc T. It may be made by attaching a penny or a small brass ball to the end of a slender rod of glass or hard rubber with a little wax. This handle should be at least 1 *foot* long.

With the complete outfit (see accompanying photograph, Fig. 1) innumerable interesting experiments may be performed. If a tube or sheet of glass is rubbed with silk, both the glass and the silk become electrified. If the proof plane is rubbed over the excited surface of either and then touched or even brought near to the metal top T of the electroscope, the leaves of the latter will *diverge* owing to the charge of electricity which has been imparted or induced in them. The nature of charge generated on the glass is called *positive*, while that on the silk, with which the glass was rubbed, is *negative*. In like manner, if a piece of hard rubber, such as a rubber comb, be rubbed with a piece of woolen cloth it will be charged negatively, while the cloth will acquire a positive charge.

It is the function of the electroscope which we have just constructed to test the nature of all of these charges, and one method of so using it is as follows: Place the hand on the top plate of the instrument, so that any charge which may remain from previous work may be removed. Now charge the leaves as directed above, noting whether the charge is positive or negative, according to the source from which it is obtained. The leaves will diverge as soon as any charge reaches them. Any additional charge will *increase* their divergence if it is of the same sign, and *decrease* it if it is of the opposite sign.



How the Electric Charge Is Distributed in the Gold-leaf Electroscope.

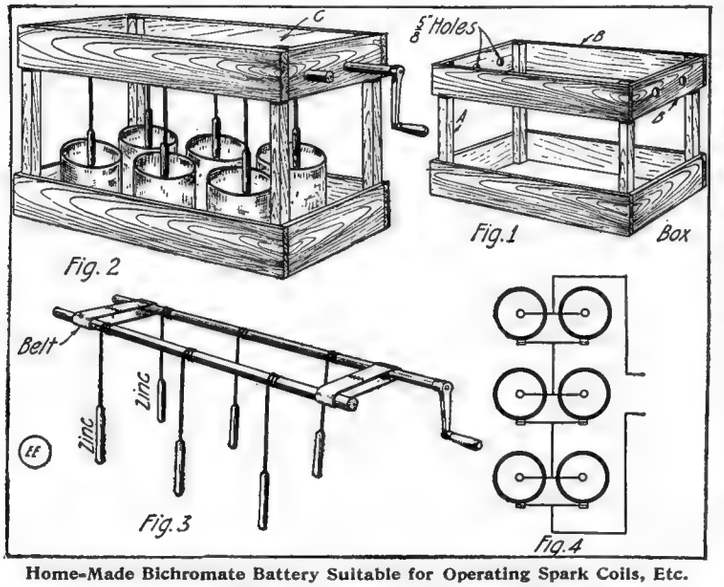
Hence, the behavior of the leaves after their first charging will indicate the nature of the charge being tested at the time. Furthermore, the magnitude of the divergence or convergence at any time will af-

(*Continued on page 206*)

* An excellent substitute for gold foil has lately been produced which is lighter than gold and does not adhere to the fingers. Upon request the Editor will furnish the name of the maker.

BICHROMATE CELLS AS THE POWER SUPPLY FOR SPARK COILS.

For operating spark coils I have used bichromate cells very successfully. Although on these kind of cells the amperage is low the voltage is high; the amperage is about 6, while the voltage is nearly 2½. These cells may be constructed as follows: Procure as many jars as you will wish to use. The jars I used were ordinary "wet" cell jars containing a carbon element with a zinc passing through the center, such as ordinarily used with a solution of sal-ammoniac and water for operating doorbells, etc.



Home-Made Bichromate Battery Suitable for Operating Spark Coils, Etc.

The solution for the bichromate cells is as follows: For each pint of water dissolve about 2½ ounces of commercial sulphuric acid, with about 2½ ounces of bichromate of potash. To prevent the zincs from being destroyed by the strong solution it is necessary to amalgamate the zincs with mercury. First procure a small paint brush, such as those used in small picture painting outfits, and also about an ounce of mercury, which will be enough to amalgamate a great many zincs. If the zincs are new ones the mercury will take to them much easier, but if the zincs have been used before they should be thoroughly cleaned with emery paper or a file. To make the mercury take to the zincs immerse the zinc in dilute sulphuric acid. Then place the zinc to be amalgamated on a board or a flat surface and put a few drops of mercury on the board or flat surface. As the mercury will not adhere to the zinc right away we will have to lay the round zinc on its side and rub the mercury into it with the brush, as though it was tinned with solder.

In order to preserve the zincs from being attacked by the acid when not using the battery we will have to lift the zincs out of the solution. A device for this purpose can be constructed as follows: Place the cells in a box and mount four uprights, A, each measuring about 14 inches high, as shown in Fig. 1. Next secure four wooden pieces, B, measuring about one-quarter inch thick, at the top of the four uprights. Two five-eighth inch holes spaced five inches apart are drilled as shown; that is, if there are only two rows of cells.

Procure a few feet of one-half inch, round wooden rod. These are cut to the length of the box plus about 1½ inches at each end. They are placed through the holes in the board, while strings connected to the zincs serve to lift them out of the jars (Fig. 2). So that the two or more rods, C, may turn at the same time, pieces of friction tape are used for the belts, as indicated in Fig. 3. If the tape is very sticky the zincs will stay raised without a weight, but if the zinc elements will not stay up alone a clamp or catch may be attached to one of the rods. A small handle can be attached to one of the drums very easily. If five of these cells are connected in series they will work well on coils up to one inch: for larger size coils a few more cells will be required, and they should be connected up as in Fig. 4. It is understood that the carbons of the former batteries are used in these cells.

Contributed by RICHARD T. AYRES.

"FIRST AID" TO TOOLS WANTED.

These tools are in daily use by mechanics in a large machine shop. They are practical and have actually been made by the mechanics. The experimenters will find them useful, easily made and possibly just what they have been wanting for a long time:

1. Hack Saw.—Made of ⅜-inch round iron and bent to shape, allowing sufficient spring to tighten saw. (Fig. 1.)

2. Tap Lever.—Material, bolt, nut and nail. Drill hole in end A, then slit with saw. Run nut C back on bolt. Insert tap and tighten nut C. (Fig. 2.)

3. Key-hole Saw.—Use broken saws, brass pipe and 2¼-inch 8-32 machine screws. Flatten end of pipe in vise. Drill and tap this for the machine screws. Insert saw which has been tapped for the screws and tighten the screws. (Fig. 3.)

4. To Prevent Breaking No. 6-32 and Smaller Drills.—Drill small brass rod deep enough to allow drill to be inserted and yet extend the required distance A; then tighten on screws BB. This acts as a stiffener and depth gauge as well. (Fig. 4.)

5. Fine Scriber.—This is made of a brass rod and a needle. Drill the brass rod and taper the end with a file. Insert the needle and solder. (Fig. 5.)

6. Ladle for Solder.—Material, 1-inch coupling and plug. The illustration shows how this ladle is made. The handle is mounted as shown at A. (Fig. 6.)

7. Flat Wrench.—Drill hole one size smaller than nut, cut out with saw; finish up with file. (Fig. 7.)

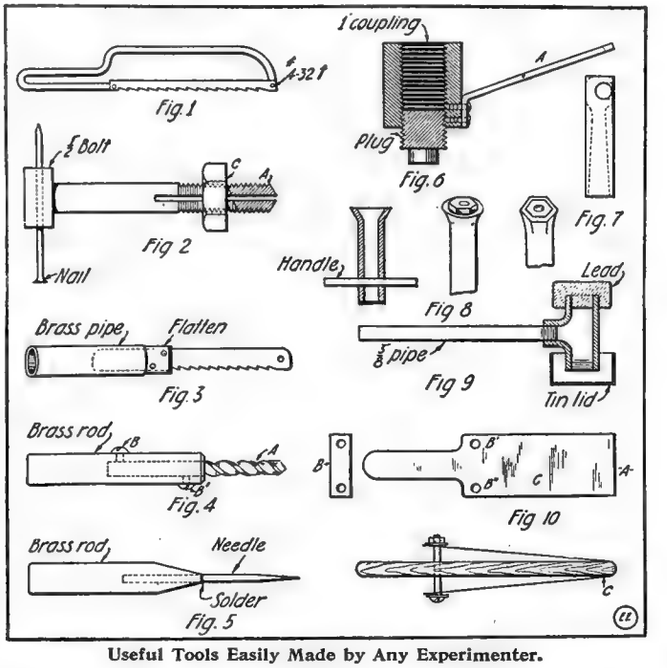
8. Hexagon Head Wrench.—The material necessary is a piece of pipe, which is expanded, while hot, with a center punch (Fig. 8), and a hexagon nut driven tightly into the end of the pipe after it is expanded. This may be made double-ended if desired.

9. Lead Hammer.—The material comprises a ⅜-inch pipe tee and a piece of lead. A tin lid is used to hold the hot lead as it is poured into the tee and then removed and placed on the other end while the operation is repeated. The threads of the tee hold the lead in place. This hammer is used for driving bearing sleeves into place, etc. (Fig. 9.)

10. Emery or Sand File.—Shape a piece of flat iron as shown in Fig. 10-A, drilling two holes for 8-32 clearance B′ B″. Make two pieces like Fig. 10-B, with holes to match up with B′ B″. Bend emery or sandpaper over at C and fasten in place by tightening the screws on the clamps.

All of these tools are in use in a large machine shop, where they have been made to fit some special piece of work for which it was hard to buy a tool that would perform the function as well.

Contributed by C. S. BUNDESMAN.



Useful Tools Easily Made by Any Experimenter.

ALUMINUM SOLDER.

Now that aluminum is used for so many electrical and mechanical purposes, it is necessary to have some kind of solder by which wires or rods made of this material may be joined. Although aluminum solder has been on the market, no serviceable brand has been brought out until recently. Now a New York firm is selling a new kind of aluminum solder. This has no aluminum in it, but no other details of the alloy have been made public. To replace the aluminum another metal is added which lowers the melting point. No flux is necessary; the wires are simply tinned and heated. The solder easily follows the ordinary copper soldering iron. Brass and bronze can also be joined to aluminum, but this requires an acid flux.

In sending, keep three fingers on the telegraph key. This will prevent a "glass arm."

Use sand paper in polishing commutators. Apply vaseline on a piece of felt sparingly.

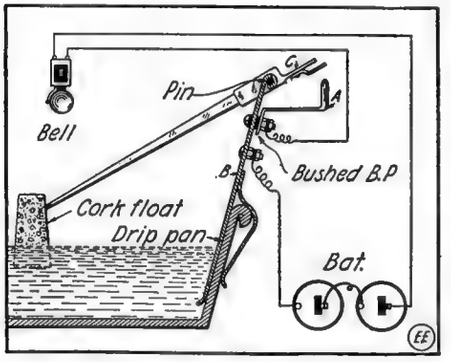
HOW TO MAKE IT

This department will award the following monthly prizes: FIRST PRIZE, $3.00; SECOND PRIZE, $2.00; THIRD PRIZE, $1.00.
The idea of this department is to accomplish new things with old apparatus or old material, and for the most useful, practical and original idea submitted to the Editors of this department, a monthly series of prizes will be awarded. For the best ideas submitted a prize of $3.00 will be given; for the second best idea a $2.00 prize, and for the third best a prize of $1.00. The article need not be very elaborate, and rough sketches are sufficient. We will make the mechanical drawings.

FIRST PRIZE $3.00

REFRIGERATOR DRIP-PAN ALARM.

The accompanying illustration almost explains itself. The material required includes an ordinary electric bell, a dry battery and the pan attachment, which is made out of No. 20 gauge copper or other metal sheet. The arm A is insulated to prevent a short circuit where it is attached to the frame B. At C a spring contact is soldered. When the water reaches the level that the alarm is set for the bell will ring its warning. The attachment may be removed from the drip-pan in a jiffy when the latter is to be emptied. A large-size bicycle pump or



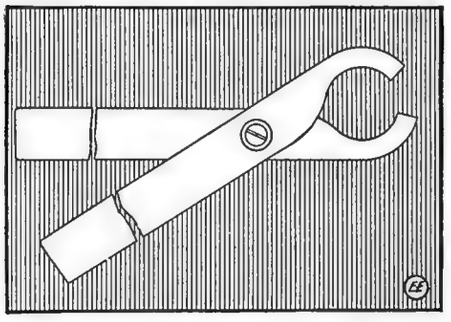
Very Useful Refrigerator Drip-Pan Alarm, Which May Be Quickly Detached, Permitting Pan to Be Emptied. Will Save its Cost Many Times Over.

syringe is useful in accomplishing this operation, especially when the pan becomes overfull, due to inattention at the proper time. This alarm has been used in our home for two years with complete success.

Contributed by HOWARD CARL.

FUSE TONGS.

From sheet fiber or thin wood cut two pieces as per illustration and drill to ac-



Shock-Proof Fuse Tongs Made of Fibre. Can Be Carried in Any Tool Bag.

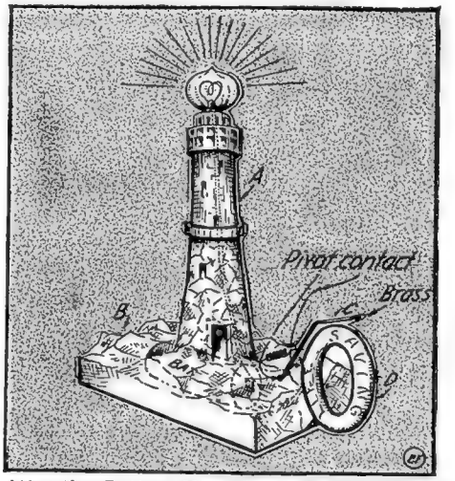
commodate a small machine screw and nut (a stout paper fastener may also be used). Very serviceable fuse tongs, ones which are in use in most large establishments, will be the result.

Contributed by ERNEST ZADIG.

SECOND PRIZE $2.00

MINIATURE LIGHTHOUSE DESIGN FOR HANDLAMP.

The tower A is made of wood and turned up in a lathe as shown. In the top of the



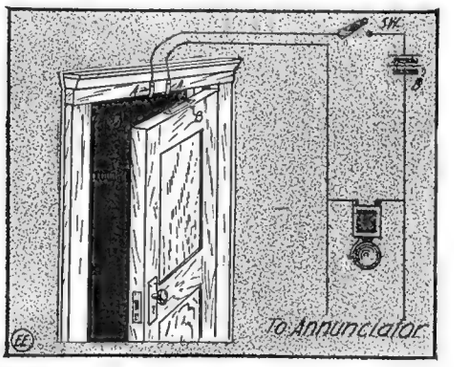
Attractive Battery Hand Lamp Made of Wood and Shells as Shown

tower a miniature receptacle is placed. The bottom is also a piece of wood carved as indicated at B. Onto this are glued some beach shells. The wooden base is hollow so as to hold the battery and switch which is operated by the pressure of the thumb on the lever C. The handle D, representing a lifebelt, is also made of wood. The light, battery, receptacle and wire can be obtained at a nominal price. This is a very pretty and useful ornament.

Contributed by ARTHUR PAUL, JR.

HOME-MADE ELECTRIC DOOR TRIP.

The accompanying illustration shows how to make a useful, yet simple, door alarm switch to close a bell circuit when door or window is closed, as in greenhouses, et cetera. A may be made from either spring brass strip or watch spring.



Electric Alarm for Doors, Comprising Two Springs AA, and a Metal Strip B.

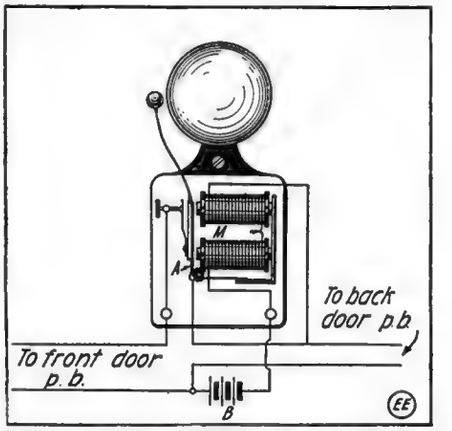
B is also of brass and is held down by small countersunk brass screws. An or-

THIRD PRIZE $1.00

ONE BELL DOES WORK OF TWO.

This suggestion is for those who have but one electric bell in the house but who would like to have two. The bell I refer to is the door bell with the push button at the front door. I needed a bell on the back door, but had only a push button and some wire. As the illustration shows, all that was necessary was to connect the wire from the rear push button to the bell, and make the connection with the same dry cells that were used on the bell for the one push button.

When the button on the back door is pushed, the two electro-magnets M draw



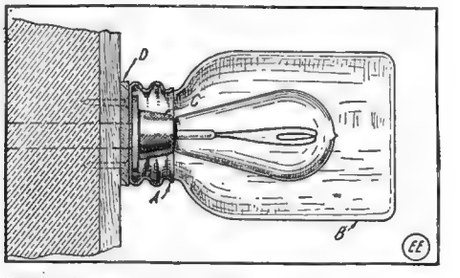
How to Connect an Ordinary Bell, so it Will Ring Differently from Two Push Buttons.

the armature A, causing the ball to strike the gong, thus making the bell a single stroke one. This creates a distinct difference between the ring when the front door button is pushed and when the back door one is pressed.

Contributed by HOBBS LANGFORD.

A WATER-PROOF RECEPTACLE.

With reference to the illustration, A is the zinc cover of a Mason jar with porcelain lining removed. B is an ordinary 1-



Converting Any Lamp Socket C, Into a Water-Proof Type With a Fruit Jar B.

quart Mason jar. C is a concealed type base receptacle. D is a rubber gasket. An ordinary fruit jar rubber is used to water-proof A and B. This device has proven very successful over my shop door.

Contributed by E. K. SNYDER.

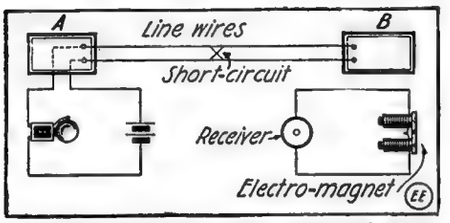
dinary bell and battery complete the outfit.

Contributed by C. STELLHORN.

SHORT-CIRCUIT FINDER FOR UNDERGROUND LINES.

With this device it is possible to find short-circuits without pulling up 75 to 100 feet of paving. It consists of an electric bell or buzzer, a set of batteries, a receiver and a pair of electro-magnets. The instruments are connected as shown in the illustration. A and B are manholes.

By holding the receiver close to the ear and the electro-magnets close to the ground, a slight hum will be heard in the receiver when the magnets are over the line wires. The line wires can then be traced to the short-circuit; the hum will be heard until the magnets are no longer over the line wires or until the short-circuit is reached. Best results can be had when the battery pressure is strong; the



A Bell Sets up Pulsating Currents in the Line and a Telephone Receiver Picks Them up as Far as X.

line wires can then be traced even when they are three feet under ground.

Contributed by
GEORGE WARNECKE.

A NEW USE FOR SANDPAPER.

Small electric light bulbs sometimes become so tightly screwed into their sockets that they can not be removed easily with the hands or pliers. In the first case the glass offers no gripping surface and in the second the pliers are liable to break the bulb. When this happens, grasp the bulb with a small piece of very fine sandpaper (No. 0), using either the fingers or pliers.

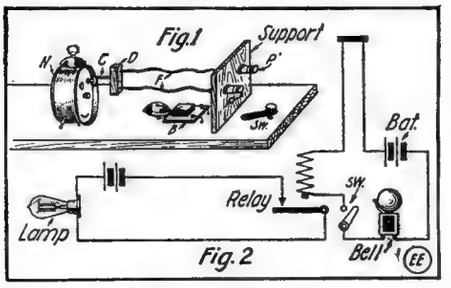
Contributed by FRANK DILLMAN.

AN ELECTRIC "EYE OPENER."

The following "early riser's alarm" may be easily constructed from a few odds and ends:

Figure 1 shows the way the various parts may be assembled, although they may be arranged to suit the builder's convenience. Referring to the illustration, N is an alarm clock, PP' are two binding posts, S a switch to control bell B and the circuit-closer F.

The part F may consist of two flexible metallic cords or chains about 3 inches or 4 inches long, fastened to the two binding posts and to D by wrapping, or by machine or wood screws. D may be a piece of



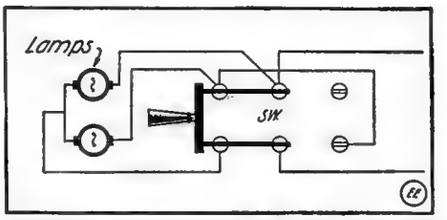
When the Clock Alarm Operates, It Twists the Bare Wires F Together, Closing the Electric Bell Circuit.

wood or fibre. C is a form of clamp to attach it to the handle of the alarm spring winder. In practise detach C, give the winder three or four turns and then put C back. At the hour for which the alarm is set it will wind the two wires F together and ring the alarm bell, which is properly connected to the circuit, until switch S is opened. By placing a proper relay in the bell circuit a light may also be turned on for dark mornings. See Fig. 2.

Contributed by L. LA MONTAGNE.

INTERESTING HOOK-UP EXPLAINED.

The following hook-up, though it sounds simple, is rather hard to connect offhand.



Throwing the Switch to Left Puts Lamps on Parallel; to Right, Lamps in Series.

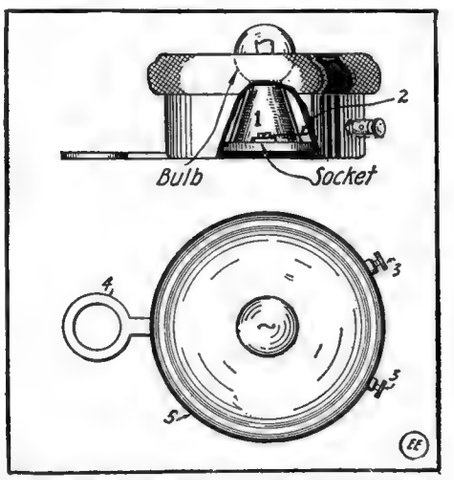
Given a double pole, double throw knife switch, connect it so that when thrown in at one end two lamps are joined in series; when thrown in on the other end the same two lamps are connected on multiple.

Contributed by DAVID KUSKIN.

HANDY BATTERY LAMPS.

The diagram represents an easily-made battery lamp socket that may be hung on a hook, etc.

Obtain a discarded "Pony" telephone receiver, remove the diaphragm and magnet.

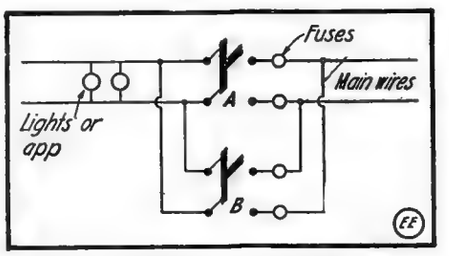


Portable Table Battery Lamp Made Fom Discarded Telephone Receiver. May be Hung on Nail.

Then take a battery lamp socket (1), with two short wires (2) just long enough to reach from binding posts (3) to center of receiver. Connect wires from socket to binding posts.

There is an eye (4) by which the socket may be hung up. When inner connections are made, put cover on receiver and screw in bulb.

Contributed by
WILLET T. CONKLIN.



If Fuses A "Blow," Throw in Switch B.

AN EMERGENCY FUSE SWITCH.

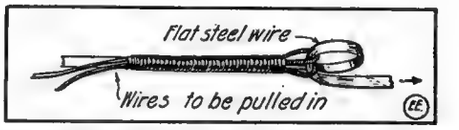
I have had the disagreeable experience of having a fuse suddenly blow out when the current is very necessary. I conceived the following method of overcoming this difficulty. Two switches (D. P. S. T.) with fuses of the necessary amperage, are required. The switch, B, is always left open and should be closed only when the fuses at A burn out. (See diagram below.) At any time when it is convenient the fuses at A can be renewed and used accordingly.

Contributed by FRANK HARAZIM.

FISHING IN CONDUIT WIRES.

A useful kink is shown herewith for the practical electrician who has to pull electric wires through conduits or pipes, etc.

A common fish wire or snake used for this purpose is made of flexible flat steel about ⅛ by 1-32 inch section. The diagram

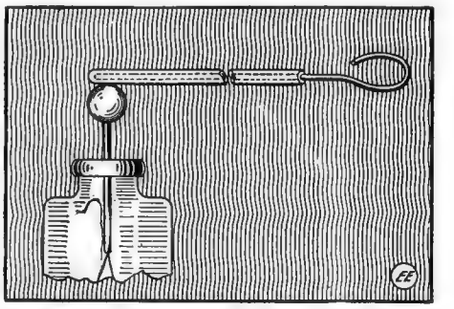


Effective Splice for "Fish" Wire Terminal as Used in Pulling Wires Thru Pipe Conduits.

illustrates a very serviceable and simple method of strongly securing the ends of the copper wires to be pulled in to the end of the fish wire. As seen, but one bend or turn is made in the fish wire, and the copper wire terminals are then passed through the loop formed and twisted around themselves and the tail of the fish wire several times. This joint should then be covered with several wrappings of friction tape. Don't forget to use plenty of soapstone on the wires as they are being pulled into the conduit. This joint has been tried out thoroughly in practise and will stand very heavy pulls without becoming undone. The tail, bent backward as shown, should be about 2 to 3 inches long for ordinary work.

GLASS AS A CONDUCTOR.

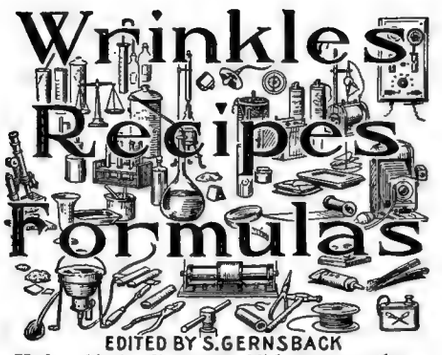
Normally glass is one of the best insulators or non-conductors of electricity, but it becomes a conductor when heated to redness. This fact may be demonstrated by a simple and striking experiment. Select a small glass tube closed at one end and fit it loosely over the end of a brass or copper wire. If the wire is held in the hand while the cap of a charged electroscope is touched with the end of the tube, the electricity will be unable to reach the wire owing to the insulating qualities of the glass. Now let the end of the tube be heated until red hot in the flame of a spirit lamp or blow pipe and then brought again into contact with the electroscope cap. The collapse of the gold leaves will at once



By Heating the End of the Glass Tube Adjacent to the Ball, the Static Charge Can Pass Right Thru the Glass.

indicate that the charge has escaped through the glass to the wire and thence through the person of the experimenter to the earth.

Contributed by H. J. GRAY.



EDITED BY S. GERNSBACK

Under this heading we publish every month useful information in Mechanics, Electricity and Chemistry. We shall be pleased, of course, to have our readers send us any recipes, formulas, wrinkles, new ideas, etc., useful to the experimenter, which will be duly paid for, upon publication, if acceptable.

FORMULA NO. 23.
Salves and Liniments.

Court Plaster.—Brush silk over with a solution of isinglass, in spirits or warm water, dry and repeat several times. For the last application apply several coats of balsam of Peru. Used to close cuts or wounds, by warming it and applying. It does not wash off until the skin partially heals.

Artificial Skin—For Burns, Bruises, Abrasions, etc. Proof Against Water.—Take gun cotton and Venice turpentine, equal parts of each, and dissolve them in 20 times as much sulphuric ether, dissolving the cotton first, then adding the turpentine; keep it corked tightly.

The object of the turpentine is to prevent pressure or pinching caused by evaporation of the ether when applied to a bruised surface. Water does not affect it, hence its value for chapped hands, surface bruises, etc.

Adhesive Plaster, or Salve, for Deep Wounds, Cuts, etc., in Place of Stitches.—White Rosin, 7 ozs.; bees wax and mutton tallow, of each ½ oz.; melt all together, then pour into cold water and work as wax until thoroughly mixed, then roll out into suitable sticks for use.

It may be spread upon firm cloth and cut into narrow strips. In case of deep wounds, or cuts, it will be found to firmly hold them together, by first pressing one end of a strip upon one side of the wound until it adheres, then draw the edges of the wound closely together; and press down the other end of the strip until it adheres also. The strips should reach three or four inches upon each side of the cut, and run in different directions across each other, to draw every part of the wound firmly in contact. It will crack easily after being spread until applied to the warm flesh, yet if made any softer it cannot be depended upon for any length of time, but as it is, it has been worn as a strengthening plaster, and remained in place over a year.

Burns.—Salve for Burns.—Equal parts of turpentine, sweet oil, and beeswax; melt the oil and wax together, and when a little cool, add the turpentine, and stir until cold, which keeps them evenly mixed. Apply by spreading upon thin cloth—linen is the best.

It is good for chaps on hands or lips, or for any other sore. If put on burns before blistering has taken place, they will not blister.

Chilblains—To Cure.—Mutton tallow and lard, of each ¾ lb.; melt in an iron vessel and add hydrated oxide of iron, 2 oz.; stirring continually with an iron spoon, until the mass is of an uniform black color; then let it cool and add Venice-turpentine, 2 oz.; and Armenian bole, 1 oz.; oil of bergamot, 1 dr.; rub up the bole with a little olive oil before putting in. Apply several times daily by putting it upon lint or linen—heals the worst cases in a few days.

(Chilblains arise from a severe cold to the part, causing inflammation, often ulcerating, making deep, and very troublesome, long continued sores.)

Warts and Corns.—To Cure in Ten Minutes.—Take a small piece of potash and let it stand in the open air until it slacks, then thicken it to a paste with pulverized gum arabic, which prevents it from spreading where it is not wanted.

Pare off the seeds of the wart or the dead skin of the corn and apply the paste, and let it remain on ten minutes; wash off, and oak the place in sharp vinegar or sweet oil, either of which will neutralize the alkali. Now do not jam nor squeeze out the wart or corn, like "street-corner peddlers," but leave them alone, and nature will remove them without danger of taking cold, as would be if a sore is made by pinching them out. Corns are caused by pressure; in most cases removing the pressure cures the corn. Nine of every ten corns can be cured by using twice daily, upon it, any good liniment, and wearing loose shoes or boots.

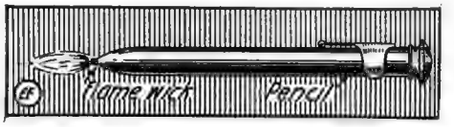
Shaking Liniment.—Turpentine and senca oils, of each 7⅓ ozs.; sweet oil and tincture of arnica, of each 3⅔ ozs.; oils of organum, hemlock, juniper, amber, and laudanum, of each 1⅓ ozs.; spirits of ammonia, ½ oz.; and gum camphor, ¼ oz.; which makes a little less than 1 qt. S. G.

PENCILS FOR WRITING ON GLASS

Stearic acid, 4 pts.; mutton-suet, 3 pts.; wax, 2 pts.; melt together and add 6 parts of red lead and 1 pt. purified carbonate of potassa, previously triturated together; set aside for an hour in a warm situation, stirring frequently; then pour into glass tubes or hollow reeds.

HANDY POCKET LAMP.

First obtain a worn out metal magazine pencil and remove the center. Next secure



Pocket Lamp Made From Magazine Pencil and Some Cotton Wick.

about 6" of yarn and soak it in melted paraffine, take it out and let it become thoroughly dry. Put it in the pencil case, allowing about ⅜" to protrude from the end. When lighted this will burn steadily for at least five minutes. When it has burned out, cut off the end and pull out about ⅜" more.

Contributed by PAUL HOBROCK.

HOW TO MAKE ICE.

1. Ice can always be purchased cheaper than it can be produced in a small way. However, it is sometimes desirable to have ice or to secure extreme cold when it cannot be purchased, on Sunday or in the night. By use of the recipe below ice may be made at home in about 20 minutes.

Take phosphate of soda.....9 parts
Nitrate of ammonia.....6 parts
Diluted nitric acid.....4 parts

Place the water to be frozen in a small dish (about 3 inches diameter) and put the dish in a large one, to hold the freezing mixture. It will require from 2 to 4 times as much of the chemical as of the ice desired. Hence, if 18 pounds of ice is wanted it will require about 18 parts of soda, 12 of ammonia and 8 of nitric acid. The outer vessel should be insulated by wrapping it in a wet blanket or paper. The water and utensils should be made as cold as possible by first immersing them in the coldest water available.

This is really a very cheap method of making ice, as the chemical may be used time and again by merely evaporating the water.

2. Gunpowder may be made by carefully mixing together 70 to 80 per cent. of nitrate of potash, 10 or 12 per cent. of sulphur, and 10 to 12 per cent. of soft wood charcoal.

3. An interesting little experiment may be performed by throwing a piece of potassium as large as a pea upon some cold water in the bottom of a large bottle. Hydrogen is given off on account of the decomposition of the water caused by the potassium, Enough heat will be given off to ignite the hydrogen, which will burn with a purplish red color. Immediately after throwing the potassium in the water a pasteboard card or glass plate should be placed over the mouth of the bottle.

4. Rochelle salts may be obtained by the following experiment: Dissolve 10 grams of cream of tartar in about 175 cubic centimeters of hot water. Add to this a strong solution of sodium carbonate as long as the addition produces effervescence. Evaporate the solution to the bulk of 20 cubic centimeters and then allow it to cool. Crystals of Rochelle salts will be obtained.

For the benefit of those who do not understand the metric system, in which the measurements in the last experiment are given, the equivalents in the English system are: 10 grams equal 154.32 grains, 175 C.C. equal 5.9 fluid ounces, and 20 c.c. equals 7 fluid ounces.

Contributed by PHILIP HOOD.

BAKED SHELLAC FOR CEMENTING GLASS TO GLASS, GLASS TO METAL AND CHINA.

In my work as a laboratory assistant I have tried many cements, but have found that none work as well as ordinary *baked shellac* used as follows:

Use an ordinary shellac and alcohol mixture, boil it down over a flame until the shellac becomes fairly thick, warm the articles to be mended a little and apply the shellac to the parts. Apply pressure to the parts by tying with wires or weighting them. Put the whole in an oven of constant temperature and bake for about twelve to twenty-four hours. The temperature of the oven is very important; it should not exceed 200°F. and by no means 212°F. Too much heat only chars the shellac and makes it bubble up. This method of cementing is so effective that pieces will break at other places rather than at the joint. The shellac, once baked well, as directed, is proof to most all acids; H_2SO_4, HCl, HNO_3, and chromic acid do not seem to affect it in any way. It is also waterproof. In fact I can find nothing so far that will dissolve or soften it. I have used an electric sterilizing oven when baking the shellac.

Another good cement, sometimes called aquarium cement, is a mixture of litharge and glycerine, made into a paste and allowed to set for two days after applying.

Contributed by FREDERICK M. HILL.

COPPER PLATING WITHOUT ELECTRICITY.

With this copper-plating solution an article can be plated in two minutes without any electric current:

Formula: Add to 350 C.C. of water 25 C.C. of pure sulphuric acid, 1 tablespoonful of copper sulphate crystals, 2 tablespoonfuls of ammonium chloride (Sal Ammoniac), 1 small teaspoonful sodium bicarbonate (baking soda). This solution will not copperplate silver, zinc, aluminum, lead or carbon, but gives tin, tool steel and nickel a fine plating. Clean the article thoroughly, then dip in the solution for about two minutes. Remove and wipe off the solution. Dip in again for two minutes and after wiping, polish the article.

Contributed by J. SCOTT HEMRY.

Experimental Chemistry

By Albert W. Wilsdon

2nd Lesson

DEFINITIONS.

THE following definitions should be remembered by the reader:

Chemistry is that branch of science that deals with matter in its simplest forms and the numerous combinations of those forms.

Matter is anything which occupies space, which we can see or feel, or which has weight. Examples of matter are: wood, water and air, etc.

A Substance is any one kind of matter. Thus hydrogen, oxygen, water, iron, etc., are substances.

Energy is the ability to do work. Every change or motion which matter undergoes is caused by some kind of energy.

A Physical Change is a change whereby the properties of the substance are not altered after the cause of the change is removed.

A Chemical Change is a change whereby the nature of the substance is affected, forming a new kind of matter with different properties.

Chemical Division may be caused by either the application of heat or by some chemical reagent.

Physical Division may be caused by cutting or crushing, or by solution.

An Element is any one kind of matter from which no other substance of less weight has been obtained. Below is given a list of the common elements with which we shall deal.

A Molecule is the smallest particle of an element or a compound which can be obtained by physical means and still retain the properties of the original substance.

An Atom is the smallest particle of a substance which can be obtained by either physical or chemical means.

Chemical Affinity or *Chemical Attraction* is the force by which union takes place between atoms of the same kind or of different kinds, or between two or more elements to form a compound.

Properties of a substance are the qualities which inhere in it and form part of it. There are three important properties of substances.

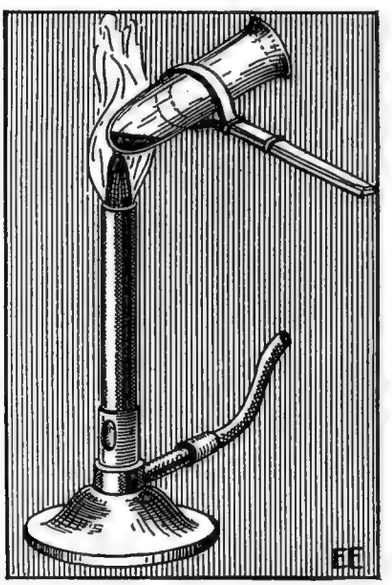


Fig. 6. How Mixtures Are Heated in the Test Tube. A Split Ring Tube Holder Is Best Employed. Move the Tube About Constantly to Distribute the Heat Evenly.

[a] *Physiological,* which show its action upon the human system;

[b] *Physical,* dealing with the appearance, color, lustre, specific gravity, etc.;

[c] *Chemical,* which we will deal chiefly with—which pertain to its affinity for other substances in regard to its combustion, etc.

The science of chemistry deals with a certain class of changes which matter undergoes. You have undoubtedly noticed, while at work or at home, various changes in different substances. You know that if a piece of wood burns, a black mass remains. You have also noticed the change of fresh milk to sour milk. When an ordinary drinking glass is dropped and broken, a change has been performed. When gunpowder is ignited, a loud report accompanied with a flash and smoke indicates the process of a change, and so are numerous other changes taking place all around us, too numerous to mention here.

If we refer to our definitions of both Physical and Chemical changes, we will readily see what kind of changes have taken place in the above examples. In the case of burnt wood, we have a Chemical Change, in that burnt wood, or as you may call it, charcoal, is really not wood. Neither is sour milk fresh milk. When a glass is broken, we still have glass but the shape or form is all that is altered by this physical change, not the composition or properties. When gunpowder is ignited, a new kind of matter is formed, which has no resemblance of the original gunpowder, so this is a chemical change.

Let us again take for an example of a physical change, the three stages of water, namely: ice, water, and steam.

If we take a piece of ice and heat it sufficiently, it will melt to form water. Let us apply heat to this water and cause it to give off steam. Now if we cool the steam we will again have water, and if we freeze the water we have the original ice which we started with.

Ice, water and steam are all the same, each being water in a different state.

The properties or composition of Ice are: H [hydrogen] and O [oxygen] Ice=H_2O.

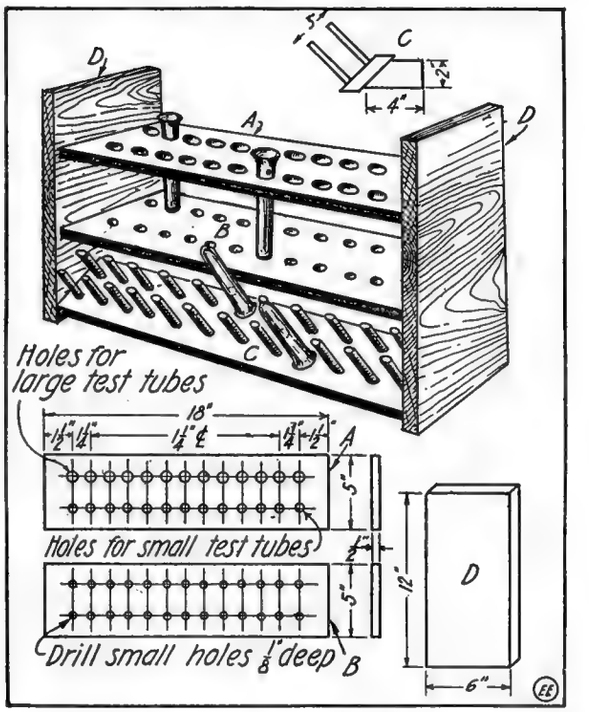


Fig. 7. Test Tube Rack Here Pictured Will Be Found Extremely Serviceable to the Chemical Experimenter. After Washing, the Tubes Are Placed, Inverted, on the Wooden Pegs at the Bottom of the Rack. When Dry They Are Inserted in the Holes in the Upper Shelf. The Bottom of Each Tube Rests in a Slight Depression Drilled in the Centre Board as Indicated in the Sketch.

Table of Elements and Atomic Weights.

Name	Symbol	Atomic Weight
Aluminum	Al	27
Antimony	Sb	120
Argon	A	40
Arsenic	As	75
Barium	Ba	137
Bismuth	Bi	208
Boron	B	11
Bromine	Br	80
Cadmium	Cd	112
Calcium	Ca	40
Carbon	C	12
Chlorine	Cl	35
Chromium	Cr	52
Cobalt	Co	59
Copper	Cu	64
Fluorine	F	19
Gold	Au	197
Hydrogen	H	1
Iodine	I	127
Iron	Fe	56
Lead	Pb	207
Magnesium	Mg	24
Manganese	Mn	55
Mercury	Hg	200
Nickel	Ni	59
Nitrogen	N	14
Oxygen	O	16
Phosphorus	P	31
Platinum	Pt	195
Potassium	K	39
Silicon	Si	28
Silver	Ag	108
Sodium	Na	23
Strontium	Sr	88
Sulphur	S	32
Tin	Sn	119
Titanium	Ti	48
Zinc	Zn	65

Water are: H [hydrogen] and O [oxygen] Water=H_2O. Steam are: H [hydrogen] and O [oxygen] Steam=H_2O. Thus:

H_2O=Ice;

H_2O=Water; and

H_2O=Steam.

You will notice that there are two atoms [see note] of hydrogen, and one atom of oxygen in the composition of ice, water and steam, therefore their properties are identical.

We shall now begin the first of our experiments, and careful notes should be made and recorded in a note book. Always remember that nothing is too small in chemistry to be noted. Record all noises, change of color, changes from solid to liquid, liquid to solid, clear solution to colored solution, colored fumes, etc.

EXPERIMENT NO. 1.

Take a piece of iron and heat it in the

(*Continued on page 207*)

[NOTE:—It will be hard for the reader to understand why the $_2$ is placed after the H in water [H_2O] until the study of the Valence of the elements are taken up. There are many other compounds with different exponents after the elements, as:

H_2O=Water

H_2O_2=Hydrogen Peroxide, etc.

Do not bother with the reason why these exponents are placed there until the time comes. All the experiments will have the formulas of the compounds so that the equation may be easily written.]

WITH THE AMATEURS

Our Amateur Radio Station Contest is open to all readers, whether subscribers or not. The photos are judged for best arrangement and efficiency of the apparatus. To increase the interest of this department we make it a rule not to publish photos of stations unaccompanied by that of the owner. Dark photos preferred to light toned ones. We pay each month $3.00 prize for the best photo. Make your description brief. Address the Editor.

AMATEUR RADIO STATION CONTEST.

Monthly Prize, $3.00.

This month's prize winner.

RADIO STATION OF KARL WILLIAM KAISER.

Having read articles in *The Electrical Experimenter* on receiving systems for undamped waves, I thought it would interest other amateurs to read the following description of my radio receiving station.

The specially designed receiving transformer is wound with "Litzendraht" and equipped with dead-end switches on both primary and secondary; all precaution being taken against dead-end effects and other losses. With this tuner and all loading inductances, wave lengths from 300 to 20,000 meters can be tuned and damped or undamped oscillations received with equal ease. Besides the tuner and inductances, a variometer has been found of great value in selective tuning. Two audion bulbs are used with the usual high voltage batteries, 1 to 1 auto-transformer and necessary inductances for the circuit.

The three variable condensers employed are fitted with extra long handles to prevent the super-sensitive circuits from being thrown out of resonance when adjusting the apparatus.

Undamped wave systems at the United States Naval stations at Darien, San Diego and Lake Park (NAJ) are often copied. On some clear nights this winter, Nauen and Hanover have been heard. With the spark systems all coast stations down to Colon can be copied, as well as many ships at a distance of 2,000 miles.

The Particularly Efficient Radio Station of Mr. Kaiser, Prize Winner. Tuning Capacity from 300 to 20,000 Meters. Nauen and Hanover, Germany, Have Been "Picked Up" with These Instruments.

The five aerial wires of stranded Antenium cable run in different directions, 125 feet in length at an altitude of 45 feet. All apparatus as shown in the photograph, excepting variable condensers and 'phones, are of my own construction and the result of reading the articles published in your magazine.

KARL WILLIAM KAISER.

Newark, N.J.

PARKER E. WIGGIN OWNS AN EXCELLENT RADIO SET.

Herewith is a photo of my radio station —9GQ. The transmitter, which is at the right, consists of a Packard one-half kilowatt transformer. The condenser has six eight by ten photograph plates with copper foil four by six pasted on either side of each plate. This condenser is submerged in oil and is located directly back of the transformer. The leads from the condenser are only three inches long. To the left of the transformer is the oscillation transformer, made up of ¾" brass ribbon. The rotary gap consists of a milled wheel having twenty-four teeth and is mounted on a polishing head stand. I use a ⅛ horse-power induction motor to run it.

Neatly Arranged Radio Set of Parker E. Wiggin. The Transmitting Set Includes a 1 K.W. Thordarson Transformer.

The receptor consists of a neat and compact cabinet set which contains a large loose coupler, primary and secondary loading coils, two high capacity variable condensers and galena and audion detectors. The audion may be used as an amplifier with the galena. I use Brandes' 2,800 ohm 'phones.

My aerial switch is in the center of the picture, with the key directly below.

My sending antenna consists of four copper wires, 60 feet long, with a 60-foot lead-in; my two receiving aerials are 550 and 250 feet long. All the aerials are supported from the top of a 70-foot pole.

Since this picture was taken I have installed a 1-K.W. Thordarson transformer and a larger condenser.

Among the stations I hear are NAA, NAR, NAX, NPH, WVG, WVD, WHK and quite a few amateur and ship stations.

I read *The Electrical Experimenter* every month and think it is the best amateur wireless help.

PARKER E. WIGGIN.

Kansas City, Kan.

RADIO CUTS BOY'S ADVENTURE SHORT.

Harry Hemore, a sixteen-year-old adventurer of Clementon, N.J., recently had his dreams of a seafaring career cut short by wireless. For a long time it had been the boy's desire to go to sea, but on account of the European war his parents objected. Their consent, however, was given for him to take a cruise to the West Indies.

Harry shipped on the Snowden Range, but instead of going to southern waters, his father learned that she was bound for Glasgow. So he sent a wireless to the captain and Harry was taken off the ship at Lewes, Delaware.

This seems to be the first wireless boomerang on record!

L. BRAINERD STRATTON'S WIRELESS OUTFIT.

The photograph of my radio station was taken while NAA was sending "time" at ten o'clock.

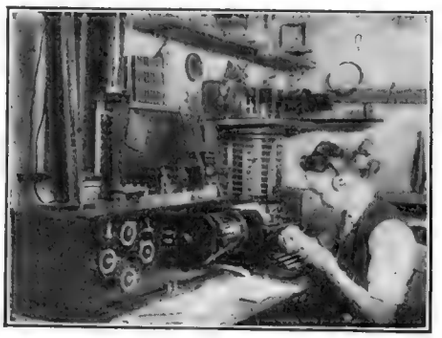
The transmitting apparatus is small, consisting of a ¼" induction coil, helix, glass plate condenser and fixed gap. I can send about two miles.

The receiving apparatus consists of two loose couplers, one small one for short waves, mounted on the front of the cabinet, and the other for long waves, mounted inside, and adjusted by switches. Three loading coils are used, one on special stations. Two of these coils are mounted on the wall and the other on the top of the cabinet. A galena or silicon detector does the rectifying. I have an original device in use for the tuning. I call it a controller. It consists of six two-point switches. By manipulating these, either the loose coupler may be used alone or with any of the loading coils. A variable condenser that may be switched either into series with the ground or in shunt with either secondary, and a small fixed condenser in shunt with the Brandes' Transatlantic type receivers completes the set.

The aerial is ninety feet high at one end and fifty at the other. It is ninety-five feet long, comprising two Antenium wires.

I have made all of my instruments with the exception of the 'phones, spark coil and small fixed condenser. NAA comes in strong at noon and still stronger at night. I can hear about twenty amateurs besides NAG, NAE, WBL, and others.

I think that *The Electrical Experimenter* is the best magazine published for all those interested in any branch or form of electricity. My official call is 2AJQ. I shall be glad to exchange station pictures.



Mr. L. B. Stratton Owns a Finely Equipped Receiving and Transmitting Station. "Time" is Being Received From NAA.

L. BRAINERD STRATTON.

Oneida, N.Y.

EXCELLENT RADIO RECEIVING SET OF W. G. HUNT.

My station consists primarily of a cabinet receiving set of my own design. The loose coupler primary measures four and one-half inches in diameter and the secondary four and one-quarter inches. Primary is wound with No. 20, and the secondary with No. 24 double silk covered magnet wire. Each binding post and switch is mounted in hard rubber bushings, care being taken that no metal touches the wood parts, and the entire top is one solid piece of hard rubber.

The primary is tapped by unit and ten point knife-blade switches, while the secondary with eleven taps, is controlled by a rod extending from the right end of the cabinet; the entire receiving apparatus being therefore enclosed and dustproof. Four variable condensers are used and very select tuning is secured. Miami, NAU, NAW, NAP, NAJ, WLC, WBF and all long distance stations come in remarkably strong, in spite of the coarse wire on the coils, which I find does the best work for me. I have had eleven sets before this one, none of which were satisfactory.

When using galena, I have a floor push under the rug, which allows the free use of both hands for testing the mineral. All the wires are concealed in the hollow table legs. I have heard Hillcrest, Cal., with this set, with two of us listening in with a set of 2,800 ohm receivers, and we have also heard Cleveland and Hatteras in the middle of the day, with plenty of sunshine to weaken the signals.

My sending apparatus is very inconspicuous, comprising a two-inch spark coil located in the cellar with a 6-60 storage battery. This circuit is controlled by a solenoid switch made out of old Western Union telegraph sounders, the details of which I hope to send at some future date for the benefit of my brother amateurs who read *The Electrical Experimenter.*

This set seems to me to be rather compact and the finish makes it an ornament

Efficient Wireless Receiving Set of W. G. Hunt with a Range of Over 3,000 Miles.

to my library, where it is now located. I use a Martin Vibroplex or "bug" for sending, as it takes up very little room, and also helps me to keep in practice with my land-line telegraph work. The "bug" works a relay near my coil, thus eliminating all high tension wires in proximity to my set, making the entire outfit fool-proof. I would install a more powerful set, but as there are already too many *Hams* creating interference with the long distance work, I prefer to listen to the far off stations than to send, and through this, keep some other eager fellow from hearing these same stations.

It may be all right to have a high power sending set available in case of emergency or war, but in these times of peace I don't believe in having unthoughtful students "sitting" on their keys.

I take pleasure in stating that nearly all my information for constructing this set was gleaned from the "E.E.," although some of the arrangements are novel.

I recently heard the S.S. *Panama,* 1,214 miles southeast of Miami, Fla., using galena, through severe interference and static. I would be glad to give any amateur any pointers he may wish from this set, although I am now installing a panel type, two step audion amplifier instead of the galena set shown herein.

The antenna is 255 feet in length, eight wires, 40 feet high. I have very little difficulty with the amateur station interference, due, I think, to the size of my aerial.

W. GEORGE HUNT.

Irvington, N.J.

RADIO CLUBS, ATTENTION!

To promote interest in the affairs of the *Radio League of America* and particularly as an inducement to all clubs and associations, we are pleased to state that the best radio club photograph and description submitted hereafter each month, will receive free one year's subscription to *The Electrical Experimenter* magazine.

Amateur News

Institute of Radio Engineers.

At the March meeting of the Institute of Radio Engineers which was held at the Engineering Society Building on March first, Mr. Harry Shoemaker, research engineer of the Marconi Wireless Telegraph Company, read an interesting paper on "Recent Standard Radio Sets." He showed the improvements in the new panel type quenched spark sets over the old stationary and rotary gap sets. Various types of transmitting panels were discussed and the rapidity with which the operator can change the wave length say from 300 meters to 450 and 600 meters respectively.

Mr. Shoemaker dwelt at length on the mechanical details of the new outfits and thus the paper proved beneficial to the radio engineers and designers interested in radio transmitter details; moreover the development of radio apparatus for ships was clearly shown and well brought out.

After the lecture a discussion was opened and various prominent radio engineers participated, including Professor J. Zenneck, Mr. Alexanderson of the G.E. Co., Dr. Goldsmith and others.

The Institute has appointed a committee for standardizing the wave lengths of radio stations so that the present interference may be reduced to a minimum.

Astoria Amateur Wireless Ass'n of Astoria, Oregon.

The above named association was recently organized in this city with a membership of fourteen, and has promise of an increase to twenty-five. The club has a one K. W. set. We have developed a portable outfit for camping purposes to be used during the summer months on long hikes.

Astoria Amateur Wireless Association, per E. P. Hawkins, president. Address 556 Grand Avenue, Astoria, Ore.

Professor Zenneck Delivers Interesting Lecture.

On February 18, 1916, at a meeting of the Radio Club of America held in the Engineering Building at Columbia University, New York City, Professor J. Zenneck delivered an interesting lecture on "Modern Radio Problems." He first discussed the damped and undamped transmitters as to efficiency. He stated that the damped station was more efficient than the undamped, in regard to power consumption; that is, power is only used when the key is closed in a damped station, while current is continually being radiated in the undamped transmitter. In the latter, as soon as the key is depressed, it short-circuits several turns of wire on the oscillation transformer and thus changes the wave length emitted, but as long as the key is in an open position, current is still being used and, therefore, a greater amount of current is required in operating an undamped transmitter compared to a damped one.

After discussing some of the properties of the most important apparatus of the transmitter, Professor Zenneck took up the receiving instruments. He explained the action of the various thermo and vacuum detectors. The action of some of the crystal detectors is still unknown, some of which operate on the thermo principle, while others operate either on rectifying or chemical decomposition principles. However, these two latter were not as yet proven and are still open for research. The sensibility of detectors operating on the thermo principle depend upon the surface exposed; the smaller the surface exposed the greater the sensitiveness of the detector.

Lastly he explained the action of iron in coils which are connected in radio frequency circuits. Dr. John Stone Stone later stated that it should be possible to use the effects of iron in coils in such circuits for producing some sort of a magnetic detector.

At the end of the lecture a discussion followed by Dr. John Stone Stone, Mr. Fritz Lowenstein and other prominent radio men. Professor Zenneck was inducted as an honorary member of the Radio Club of America.

Amateur Hears Arlington Honolulu Radio Speech.

Edward A. Baird, of 407 Oakland avenue, manager of the Pittsburgh Office of the Western Union Telegraph Co., bears the distinction of being one of the few men in the amateur radio world to undergo the novel experience of hearing a long distance wireless speech.

He was astonished to hear a human voice counting: "One-two-three-four," and then "This is Webb." Not believing his ears, Mr. Baird called in a neighbor who took the receiving instrument and is said to have heard the voice too. The next morning Mr. Baird learned through newspapers that the words he intercepted had been telephoned by wireless from the Government station at Arlington, Va., to Paris and Honolulu.

Trenton, N. J., Radio Club Talks With Florida.

At one of the winter meetings of members of the Trenton, N. J., Y. M. C. A. Radio Club, George Hill established a long distance record for the club by getting in touch with Pensacola, Fla.

A new four-wire aerial will be erected for sending purposes, as the club is contemplating the purchase of a one-quarter kilowatt transformer, and the organization is rapidly assembling the set.

Fall River, Mass., Wireless Students Form Radio Club.

Realizing that organization is the backbone of common advancement the radio amateurs of this city have organized a society known as the Fall River Radio Association.

All of the initial members were students of the Technical High School, but the right of membership is extended to all local wireless amateurs.

A constitution has been drawn up by a special committee and approved by the association. The constitution requires three officers, president, vice-president and secretary. They will be known as operator-in-chief, assistant operator and correspondence operator, respectively. The officers are: Operator-in-chief, A. G. Shirt; assistant operator, R. S. Sutcliffe; correspondence operator, L. T. Phelan; faculty director, L. A. Winder, of Technical High School.

Meetings will be held each Monday at 1.45 p. m. in room 4 of the Technical High School, but will be changed to evenings in the near future.

Election of Officers of the Tiffin, Ohio, Radio Club.

The recent election of the Tiffin Radio Club resulted as follows: President, R. Morganstern; Vice-President, Herbert Shuman; Secretary and Treasurer, Murel Sager. The club has hopes of persuading the Board of Education to install a radio set in the high school, which is the club's headquarters. All correspondence should be addressed to the Secretary, Murel Sager, 44 Apple St., Tiffin, Ohio.

RADIO CLUBS ATTENTION!

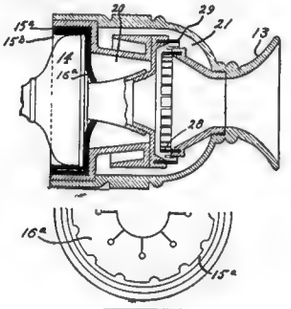
We are always pleased to hear from young Edisons and Radio Clubs. Send a write-up of your Club with photos of members and apparatus to-day to: Editor "Amateur Gossip" Section, The Electrical Experimenter, 233 Fulton St., New York City.

LATEST PATENTS

Sound Muffler for Telephones.

(No. 1,177,617; issued to Lawrence B. Gray.)

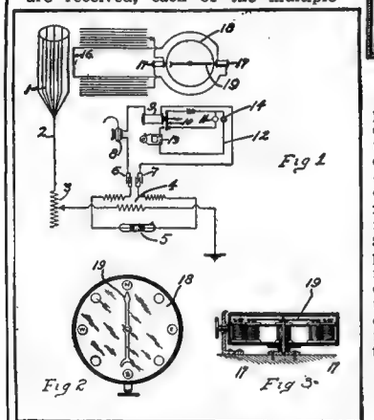
Another attempt in the production of a telephone muffler, comprising a detachable outer shell, which carries a mouthpiece 13. The voice waves proceed inward and impinge on the diafram of the usual microphone 14. Further distribution of the sound is checked, the inventor maintains, by virtue of the felt baffle rings 28, 29, 15a, 16a, and air pockets 20, 21. However, no efflux of air pressure is allowed for and as the air (especially when talking into a muffler) has to get out somewhere, it is not apparent just how the inventor intends to gain efficient results. The three slots at the base of the standard telephone mouthpiece takes care of the air circulation.



Wireless Safety Ship Signal.

(No. 1,177,708; issued to Paul Juhasz.)

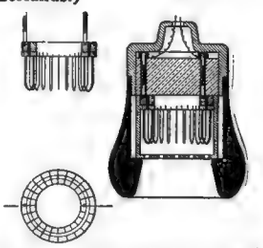
The diagram depicts a multiple wave receiving antennae 1, so arranged aboard ship as to locate definitely the various points of the compass. These multiple wave receiving antennae are then connected togther to form a single receiving wire 2 and connect with the usual wireless receiving apparatus, composed of a tuning coil 3, the jigger 4, the coherer 5 and the condensers 6—7 and then leads from there to the usual receiver 8; also a relay 9, actuating an armature 10, of a normally closed light circuit 11, to cause the closing of the bell circuit 12, and a danger light signal 14. Audible and visual warning are thus produced as soon as the wireless message is received. To determine the direction from where the waves are received, each of the multiple



antennae 1 is surrounded with a suitable inductance coil 16. The induced current is led to the inductance coils 17, which are located similarly, with relation to each respective multiple wave receiving antenna, in circular fashion about a dial 18, upon which is mounted the polarized galvanometer needle 19, which is attracted to those coils which receive the strongest electrical impulse, thereby indicating accurately the position from which the current was sent.

Thermic Telephone

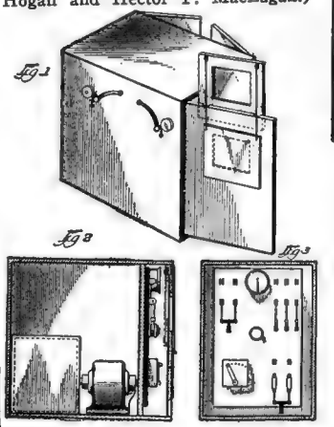
(No. 1,174,554; issued to Otto Fisher, of Utrecht, Netherlands, assignor to Naamlooze Vennootschap de Nederlandsche Thermo-Telephoon Maatschappij, of Utrecht, Netherlands.)



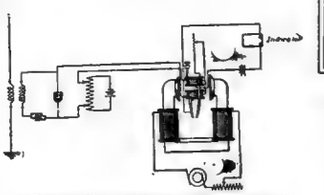
This relates particularly to specific manufacturing details in making thermic receivers, covering improvements in treating the Wollaston wire, subdivision of the heating or thermic elements in a 'phone of the type shown, so that one loop may be removed for repairs, etc. The loops are secured, by soldering or riveting, to a pair of annular conducting rings separated by an insulating ring. The loops are all connected in multiple. Fluctuations in the line current cause a corresponding change in the heating of the thermic loops, which in turn, give off sound. The whole device fits inside the ear directly against the auditory meatus.

Cabinet for X-Ray Apparatus.

(No. 1,175,450; issued to Geo. R. Hogan and Hector P. MacLagan.)



An X-Ray cabinet combining a plurality of walls constituting a part of a cabinet for containing the electrical apparatus, and a door for closing the end of said cabinet, said door comprising in part a surface of material opaque to X-rays, a frame mounted upon the door and movable to a position extending above the top of the door, and a pane of glass opaque to X-rays carried by said frame. This frame comprises in part a sheet of material opaque to X-rays, a fluorescent screen, and devices operated from behind the door for moving the screen vertically as desired.



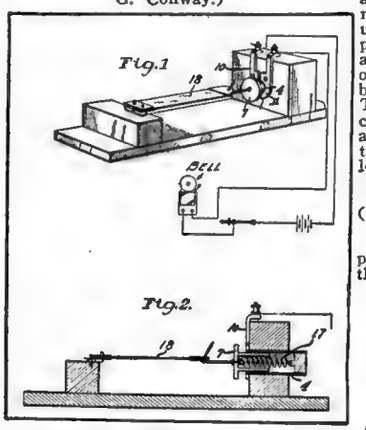
Recording Wireless Receptor

(No. 1,176,282; issued to Reginald A. Fessenden.)

In order to obtain an increased effect to permit the use of a call or a recording mechanism Dr. Fessenden employs in the receiving station a source of intermittent or alternating current having the same frequency as the group frequency of the signaling impulses. By the use of this independent source of intermittent or alternating current, he obtained a powerful alternating magnetic field and arranged in said field a coil or coils connected in the receiver circuit through which flow the currents produced by the receiver waves having a frequency corresponding to the group value. There is thus a mutual action between this coil or coils and the independently excited A. C. field. As the latter may be made as strong as desired the degree of interaction may be made great indeed. The moving coil closes a local circuit through a siphon recorder.

Circuit-Closer for Rain Alarm.

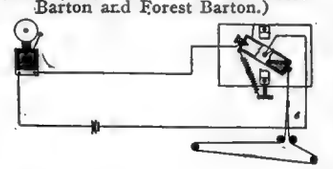
(No. 1,174,827; issued to William G. Conway.)



Unique form of circuit-closer for rain alarm devices, featuring a treated *paper* or other fuse 18, which normally holds the metal plunger 7 away from the two metal segments 10 and 11. These segments when short-circuited by the plunger 7, complete the electric bell circuit as perceived. The plunger works with an insulated sleeve 4. A retractile spring 17 tends to constantly pull the part 7 toward the two segments. Tissue paper will work fairly well in such a device.

Automatic Fire Alarm

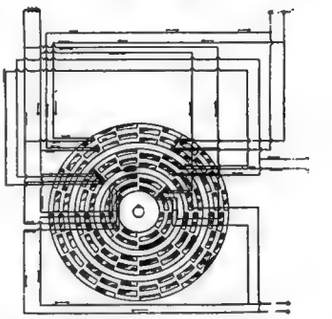
(No. 1,176,809; issued to Herbert Barton and Forest Barton.)



In this fire alarm system an inflammable cord or string is mounted on pulleys about the space to be guarded and the ends of the string terminate in an eye on the lower end of a hollow, pivoted cylinder. An electric bell circuit is connected up with this pivoted cylinder, which contains mercury. A fire fuses the cord, releasing the cylinder and ringing the bell.

D.C. to A.C. Converter

(No. 1,179,239; issued to Peter Thalassinoz.)

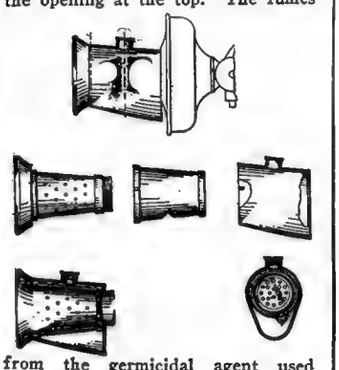


A converter of the revolving segment type is here proposed, whereby direct current may be changed into alternating current at one or any number of frequencies, depending upon the size and design of the apparatus. Each of the A.C. circuits are reversed by the brushes passing over the revolving segments, the brushes being mounted in pairs. The pairs of brushes of one circuit are spaced approximately 90° apart from the pairs of brushes of the other circuit to reduce surface leakage.

Sanitary Telephone Mouthpiece

(No. 1,176,900; issued to Ed Monroe Jenkins.)

Liquid disinfectants may be poured into the receptacle through the opening at the top. The fumes

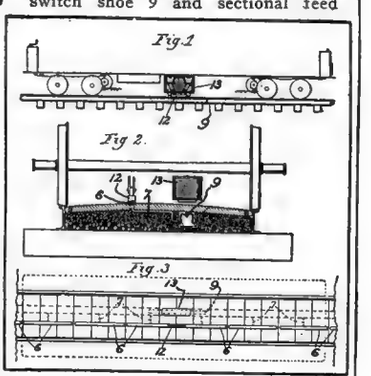


from the germicidal agent used pass through the perforations in the shell and kill all germs lodging in the mouthpiece proper.

Trolleyless Electric Railway.

(No. 1,177,551; issued to Joseph B. Strauss.)

A novel trolleyless electric railway system utilizing sub-divided exposed third rails 6, 6, 6, etc. These rails are connected successively (under the car only) by means of an electro-magnet 13, which closes the power circuit thru a traveling switch shoe 9 and sectional feed



lines 7. A third rail shoe 12 conducts the current to the car motors.

COPIES OF ANY OF THE ABOVE PATENTS SUPPLIED AT 10c. EACH.

Phoney Patents

Under this heading are published electrical or mechanical ideas which our clever inventors, for reasons best known to themselves, have as yet not patented. We furthermore call attention to our celebrated Phoney Patent Offizz for the relief of all suffering daffy inventors in this country as well as for the entire universe.

We are revolutionizing the Patent business and OFFER YOU THREE DOLLARS ($3.00) FOR THE BEST PATENT. If you take your Phoney Patent to Washington, they charge you $20.00 for the initial fee and then you haven't a smell of the Patent yet. After they have allowed the Patent, you must pay another $20.00 as a final fee. That's $40.00 ! ! WE PAY YOU $3.00 and grant you a Phoney Patent in the bargain, so you save $43.00 !! When sending in your Phoney Patent application, be sure that it is as daffy as a lovesick bat. The daffier, the better. Simple sketches and a short description will help our staff of Phoney Patent examiners to issue a Phoney Patent on your invention in a jiffy.

P. O. B. 91
$\sqrt{\text{R. F. D. } 16\frac{1}{2}}$
P. D. Q.

PHONEY PATENT OFFIZZ

IMA HAYSEED OF COWSLIP, COWLIFORNIA
ALARMDRESSER

Specifiications of Pattent Betters.

Patended Ad Lib .

To Whom It Mightn't Consarn:

I, Ima Hay Seed, a native of Cowslip, County Somebull, in the State of Cowlifornia, have, by unceasingly exercising my half-baked bean, at last perfected a device which will awaken the sleepiest hay shaker that ever was kicked in the chins by a pink-eyed Cowlifornia cow.

The action of this de-vice is as follows: When the hired man has finished the chores at night, he climbs up among the rafters of the hay-loft where all the bats and owls sleep. He stretches out on the bed, and pulls over him the old blanket I used to keep the plow horse warm in the winter time. As soon as his snoring reverberates in the quietness of the night, I know all is well until morning. As soon as the sun first squints one eye over the hill of our back pasture, however, there is something stirring. The heat of the sun, shining through window is focussed on the string, 2, by the magnificent magnifying glass, 1. This burns the string, and closes the switch 3. At this moment the motor, 4 winds up the string, 5, until support 6 is pulled out from under the load. Then, by crackey, I'll be switched if the weight, 7, doesn't pull up board 8, and tip the bucket, 9, right on the hired man, Joshuay. This bucket contains a mixture my great aunt Lizzie Maria told me about, way back when she married her seventh husband, Hezikia Couldn't-scratchem. Now this mixture is a combination of smelling salts, mouth-wash, hair tonic and shoe blacking.

As the kettle goes over, it pulls the string, and closes switch 10. Thereupon that old window, 13, is released by the catch 12, and down it goes, pressing spring 14. By this time the man is semi-conscious but still unable to get up before the magnet 15 pulls over the catch 16. The bed, 17, drops down kerbang, and Joshuay shoots out of it as fast as lubricated lightning. Right in front of him are his trousers, 19, so that he gets in them on the fly, without knowing it, really. But just as he starts down the shoot, the spark coil, 21, energized by closing of contact 20, gives him such an unearthly shock in the seat of the pants at 22, that he rises right up like the ghost of our minister, down at the haunted corner, who was shot in the neck with a stray wireless wave. As he described the arc 23, he falls on his chin, and shoots right into his calico shirt, 24, and on down to the cowbarn. By the time he lands in the stable he is wide awake and ready for business.

What I claim is:

1. A device actuated by the sun's rays, which will wake up any hired man who ever spat tobacco under Josh Finigan's stone at the post office.

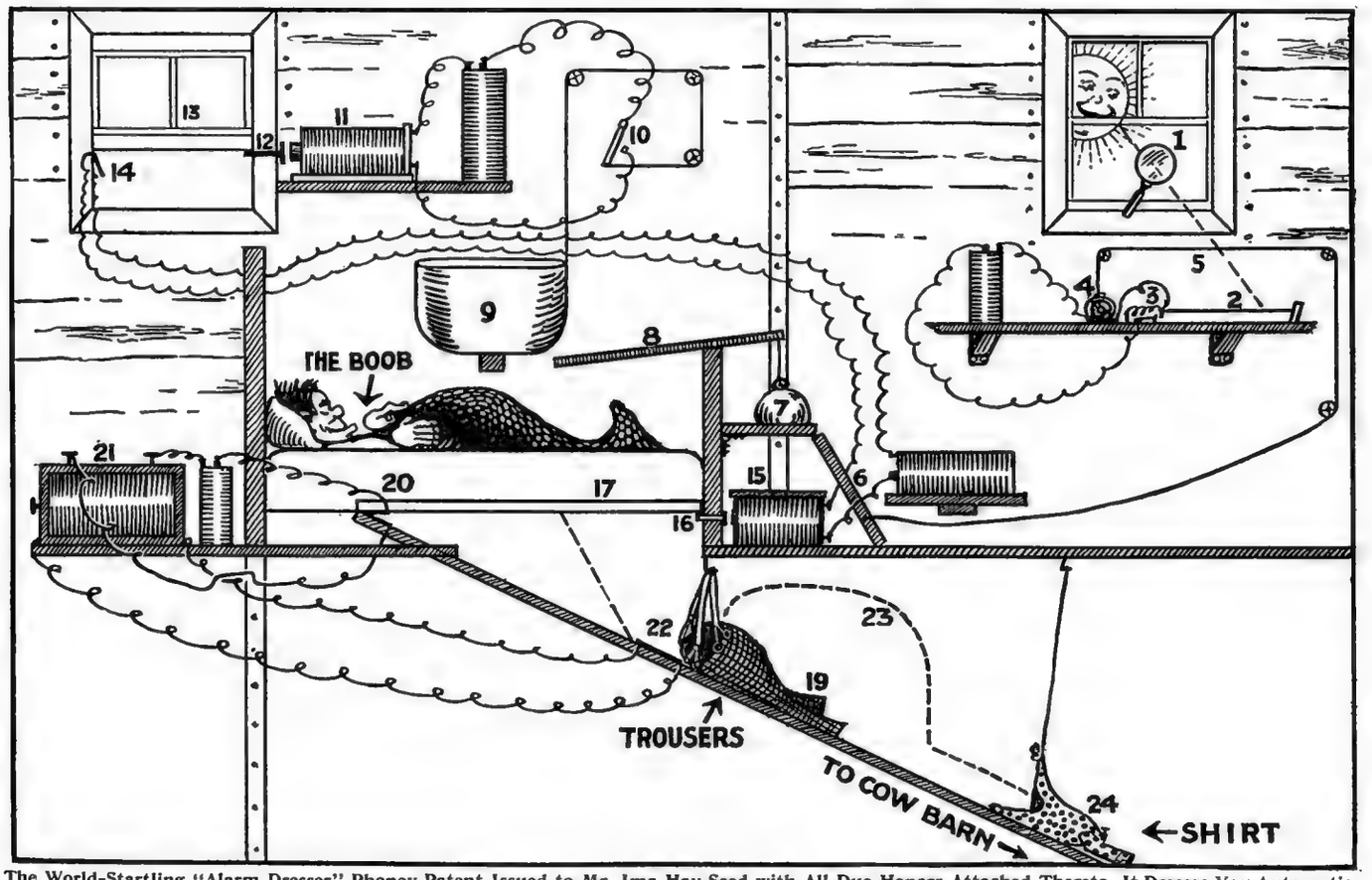
2. A device which will make, wash, and dress a man in 37.525 seconds, provided he doesn't want a regular swim, or doesn't wear any more than the usual summer allowance of clothing.

3. A device which can be used to advantage in waking all kinds of poor white trash and for husbands who won't get up in time to cook breakfast and wash the dishes.

In testimony whereof I put the sign and seal of a left hind rabbit's foot, shot in the light of the full moon behind the gravestone of Aunt Geehosofat Jiminycrikets.

IMA HAY SEED,
By his attorney,
Kenneth Bolles.

Witnesses:
A. N. Onymous.
A. Bill Ion,
Jim Nasium.



The World-Startling "Alarm Dresser" Phoney Patent Issued to Mr. Ima Hay Seed with All Due Honors Attached Thereto. It Dresses You Automatically, Instantaneously and Simultaneously with the Rise of Old Sol.

QUESTION BOX

This department is for the sole benefit of the electrical experimenter. Questions will be answered here for the benefit of all, but only matter of sufficient interest will be published. Rules under which questions will be answered:

1. Only three questions can be submitted to be answered.
2. Only one side of sheet to be written on; matter must be typewritten or else written in ink, no penciled matter considered.
3. Sketches, diagrams, etc., must be on separate sheets. Questions addressed to this department cannot be answered by mail.

RADIO TELEPHONY

(544.) Louis M. Folsom, Maine, wishes to know:

Q. 1. What is the highest frequency at which an induction coil can be operated using a mechanical interrupter of the commutator type?

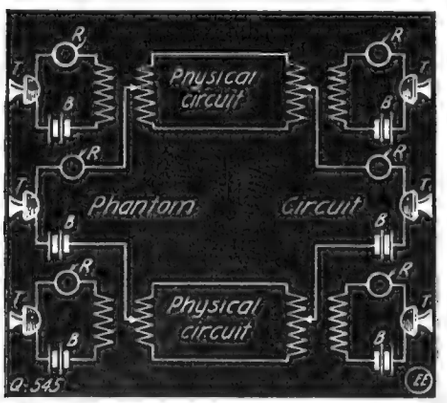
A. 1. The highest frequency at which an induction coil can be operated by a mechanical interrupter is 5,000 breaks per second, approximately.

Q. 2. What is the lowest spark frequency at which an induction coil would have to be operated in order to work successfully as a wireless telephone transmitter, provided it were possible to operate a coil at that frequency?

A. 2. 15,000 cycles per second. Lower frequencies result in a rough note in the receivers and breaks in the reproduced speech.

TELEPHONE PHANTOM CIRCUIT.

(545.) J. H. Brandbury, Chicago, Ill., wishes:



Phantom Hook-Up for Three Talking Circuits Over Four Line Wires.

Q. 1. A phantom circuit for two stations.

A. 1. The diagram herewith shows the wiring connections of a phantom circuit for two stations; the third station circuit being the phantom.

Q. 2. What size wire is used for "toll" or long distance circuits from town to town?

A. 2. Hard-drawn copper wire about No. 8 B & S.

Q. 3. How is long distance transmission rendered possible?

A. 3. By eliminating the inductive disturbances and decreasing the impedance of telephone lines. Full metallic circuits are positively essential. In transcontinental telephony audion amplifiers are made use of.

DUDDELL MOVING COIL OSCILLOGRAPH.

(546.) M. Fitzgerald, Newark, N.J. wants to know:

Q. 1. How are the oscillograms obtained in the Duddell moving coil oscillograph?

A. 1. In all cases the oscillograms are obtained by a moving spot of light tracing out the curve connecting current or voltage with the time functions. The source of light is an arc lamp, the light from which passes first through a lens, and then (excepting when projected on a screen) through a rectangular slit about 10 mm. long by 1 mm. wide. The position of the lamp from the lens is adjusted until an image of the arc is obtained covering the three (two moving, one fixed) small oscillograph mirrors. The light is reflected back from these mirrors and, being condensed by a lens which is immediately in front of them, converges until an image of the slit is formed on the surface where the record is desired. All that is necessary now to obtain a bright spot of light instead of this live image is to introduce into the path of the beam of light, a cylindrical lens of short focal length.

Q. 2. What is the function of the mirrors on the vibrating vane?

A. 2. They simply control the direction of the beam of light.

TO OUR FRIENDS.

Do you realize that not one day passes when we do not receive from 150 to 250 letters addressed to the "Question Box"? If we were to publish all the questions and their answers we would require a monthly magazine five or six times the size of The Electrical Experimenter with no other matter but questions and answers! Of late the influx of letters has become so heavy that several of our associates have been forced to discontinue important editorial work, in order to answer the mail. This we are certain you do not wish. You do not want your magazine to lower its present high standard. You want the best, the very best, and you know we never have failed you yet.

Moreover the multitude of letters are wholly unnecessary. Most of the questions we are asked every day have been answered before in the Question Box. Therefore ere you sit down to write to us, look over your back numbers and nine times out of ten you will find the answer.

We strive hard to publish only such matter as has not appeared before in our columns, and for that reason only a small fraction of queries of those received by us are actually published.

Kindly note, therefore, that in the future we can not, in your own interest, answer questions by mail, free of charge.

For questions requiring immediate answer our fee is 25c. for the first three ordinary questions and 25c. for each additional question. Will gladly advise fee for special questions entailing considerable calculations or research. Stamped and addressed envelope should be enclosed with the queries and, moreover, any sketches accompanying them should be made on separate sheets. And please be brief.

THE EDITORS.

Q. 3. What kind of recording apparatus is used with the Duddell oscillograph?

A. 3. A falling plate camera or a cinematograph film camera is employed in recording the curves.

ROTARY CONVERTER QUERIES.

(547.) U. P. Molby, Jamaica, L.I., desires to know:

Q. 1. What feature of operation is inherent in a rotary converter?

A. 1. A rotary converter is a reversible machine; that is to say, if it be supplied with direct current of the proper voltage, at its commutator end, it will run as a direct current motor and deliver alternating current to the collector rings. While this feature is sometimes taken advantage of in starting the converter from rest, the machine is not used permanently in this way. Its commercial application is usually for the conversion of alternating current into direct current.

Q. 2. What is the objection to a single phase rotary converter?

A. 2. It is not self-starting and is, moreover, less efficient than the multiphase converter.

ARC LAMP OPERATION.

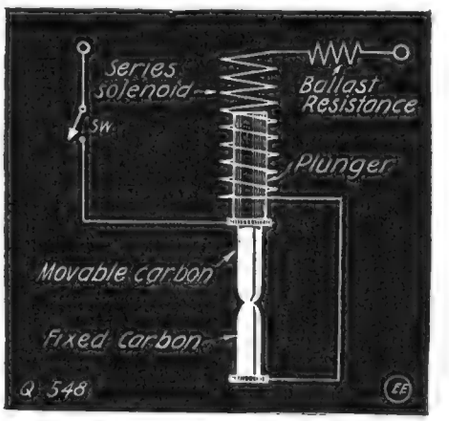
(548.) R. Flanders, Atlanta, Ga., wishes to know:

Q. 1. How a series feed arc lamp works, and the connections of the auxiliary apparatus used.

A. 1. The connections are given herewith. The carbons are initially in contact, but as soon as the current flows in the series coil, the carbons are pulled apart and an arc is formed. If the arc is too long, the resistance increases and the current is therefore lowered so that the pull of the solenoid is weakened and the gap is reduced. A dash pot prevents jerky movements of the carbons.

Q. 2. Describe briefly the rail bonds.

A. 2. A rail bond consists of a bundle of copper wires the ends of which are welded together and to the terminals by which it is attached to the rails outside the fish plates. In some forms the terminals have holes drilled through the center of the shanks. These shanks are inserted in



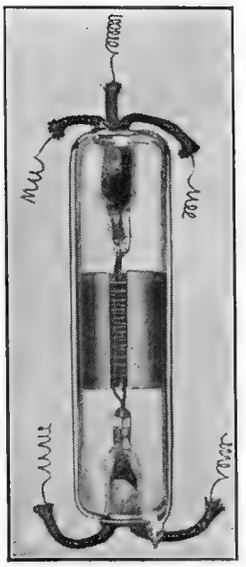
Connections of a Series D. C. Arc Lamp, Including Ballast Resistance.

(*Continued on page 194*)

DOUBLE FILAMENT

THERMO TRON

$5.25 POST PAID



The Thermo Tron is recommended very highly by college professors and advanced experimenters throughout the country. :: :: :: ::

WARNING—The success of the Thermo Tron has caused unguaranteed, inferior single filament imitations to appear on the market. :: ::

GUARANTEE—Every Thermo Tron is guaranteed sensitive, and is further guaranteed to reach the user in perfect condition. :: :: :: :: ::

DEALERS AND JOBBERS—Here is your chance to cash in on the enormous demand for the THERMO TRON. The THERMO TRON is not an infringement of any patent. :: :: ::

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The Thermo Tron Company

940 West Twentieth St., Los Angeles, Calif.

THE ELECTRON RELAY

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EUGENE T. TURNEY CO., Inc.
2595 THIRD AVE., NEW YORK

QUESTION BOX.

(*Continued from page 192*)

the holes in the rails and then expanded to a tight fit by means of beveled steel pins driven into the holes.

Q. 3. What is the quickest method of determining the wave length of a given antenna?

A. 3. Multiply the total length in feet of the aerial system by 4.7 dividing the result by 3.28, which gives the result in meters. It should be understood that the result obtained is *only approximate.*

SELENIUM SOLVENT.

(549.) L. Peters, Columbus, Ohio, desires to know:

Q. What chemical will dissolve selenium?

A. 1. Sulphuric acid will dissolve selenium.

Q. 2. Give composition of luminous paint.

A. 2. Luminous paint consists of phosphorescent calcium sulfide mixed with linseed oil. This material is applied in the same manner as ordinary paint.

Q. 3. How is chlorine gas generated in the laboratory?

A. 3. Chlorine gas is generated by heating a mixture of sulphuric acid, manganese dioxide and common table salt (sodium chloride). The mixture is placed in a generating flask and the gas is collected in bottles. CAUTION: Do not inhale the gas as it is the most dangerous gas known.

STARTING A POLYPHASE CONVERTER.

(550.) Z. Blackwell, Toledo, Ohio, wants to know:

Q. 1. How a polyphase rotary converter is started with alternating currents?

A. 1. This may be done by applying the alternating pressure directly to the collector rings while the armature is at rest. There need be no field excitation; in fact the field windings on the separate pole pieces should be disconnected from each other before the alternating current is applied to the armature, otherwise, a high voltage will be induced in the field windings which may prove injurious to their insulation. The passage of the alternating current in the armature windings produces a magnetic field that rotates about the armature core, and induces in the pole pieces eddy currents, which, reacting on the armature, exert a sufficient torque to start the converter from rest and cause it to speed up to synchronism.

Q. 2. How much alternating current is required to start a polyphase converter?

A. 2. About 100 per cent more than that required for full load.

Q. 3. What is the best resistance for phones which are to operate with an audion detector?

A. 3. 1,500 to 2,000 ohm phones should be used for best results.

TELEGRAPHONE TALKING HEAD.

(551.) Howard J. Cochran, Woodlawn Pa., inquires:

Q. 1. Where he can buy a *Talking Head* for the construction of a telegraphone.

A. 1. We do not know of any concern that manufactures *Talking Heads* for telegraphones, but we would suggest that it can be readily built by a machinist, if the dimensions as specified in the June, 1915, copy of *The Electrical Experimenter* are followed correctly.

Q. 2. Whether he can purchase a complete telegraphone and from what company?

A. 2. The only company that sells complete telegraphones is the Telegraphone Sales Co., 50 Pine Street, New York City.

COMMUTATOR QUERY.

(552.) John Fitzgerald, Memphis, Tenn., asks:

Q. 1. What will happen with an overheated motor commutator?

A. 1. It will burn up the carbon brushes and cover the commutator with a black film which offers a high resistance and increases the heat. Severe sparking usually ensues.

Q. 2. What should be done if carbon brushes become hotter than the other parts?

A. 2. Use carbon having a higher conductivity. Reduce length of the brushes by adjusting the holders to grip the brushes nearer the commutator. Reinforce the brushes with copper gauze, sheet copper, or wire, or use some kind of combined metal and carbon brush. Increase the size or number of brushes if necessary, so the current does not exceed 30 amperes per square inch of contact.

Q. 3. What are some of the causes of armature heating?

A. 3. Eddy currents, moisture, unequal strength of magnetic poles, operating the machine above rated voltage, below normal speed, and short-circuits.

TELEPHONE LINE AS AERIAL.

(553.) Roger Hackney, Kansas, inquires:

Q. 1. Does it weaken radio signals to use small iron or steel tacks in mounting a tuning coil or loose coupler tube?

A. 1. Iron nails have very little effect upon the working conditions of the tuning coil or loose coupler, providing they are used with an ordinary detector, but if an oscillating audion is used in conjunction with the tuning instrument containing the nails, it will be found that the results obtained will be less efficient than if the iron nails were not used, due to the eddy currents induced in them.

Q. 2. Can a telephone line be used as receiving aerial and does it interfere with the use of the telephone?

A. 2. A telephone line can be used as a receiving aerial by connecting a large condenser of about 0.5MF. in series with the coupler, or tuning coil and the connection to the line. Very little interference is caused on the telephone line by using it as an aerial.

TIKKER QUERY.

(554.) Max C. Van Antwerp, Ill., inquires:

Q. 1. What is a tikker?

A. 1. A tikker is an instrument used as a detector for receiving sustained wave transmitters. It consists usually of a fine wire touching a rapidly revolving commutator, used for breaking up the sustained wave to a periodicity audible in the telephone receiver.

Q. 2. If the vibrator of a wireless spark coil is taken off, can it be operated on the alternating current from a step-down transformer?

A. 2. The spark coil cannot be operated by the step-down transformer when the vibrator is removed as the frequency is too low and the A.C. wave is not peaked enough.

RESISTANCE PROBLEM.

(555.) Peter Hanley, Texas, sends this problem:

Q. 1. A millivoltmeter has a resistance of 15.4 ohms. What resistance must be connected in series with the instrument so that the scale reading may give volts instead of millivolts?

A. 1. A coil having a resistance of 15,384.6 ohms, or 999 times the resistance of the meter, must be connected in series with the millivoltmeter coil, in order to convert the meter to read in volts. This can be seen by applying Ohm's law.

Q. 2. A carbon filament glow lamp has a resistance of 277 ohms at O°C., and a resistance of 220 ohms at 1000°C. What is the mean temperature coefficient of the filament between O°C and 1000°C?

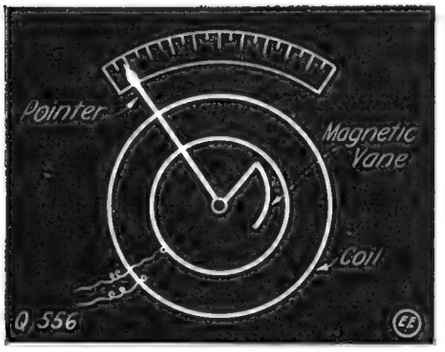
A. 2. The mean coefficient of resistance of the filament is .000206 ohm.

Q. 3. How often should a storage battery be charged?

A. 3. At least once in four weeks, even if the use be only slight in proportion to the output capacity.

MAGNETIC VANE INSTRUMENT.

(556.) John Meurhead, Cleveland, Ohio, wishes to know:



The Magnetic Vane Measuring Instrument Depends for Its Action on an Uneven Magnetic Field Witnin the Coil.

Q. 1. The principle upon which the magnetic vane measuring instrument works.

A. 1. The schematic diagram shows how the instrument is made. The principle upon which the instrument works is that a piece of soft iron, pivoted in a magnetic field, will move into such position that it will be in the strongest part of the magnetic field. The current to be measured is passed around the coil, producing the magnetic field. The magnetic flux inside the coil is strongest near the inner edge, hence the iron vane moves so that the distance between it and the inner edge of the coil will be a minimum. The magnet moves against the restraining force of a hair spring.

Q. 2. What effect has a battery and potentiometer on a radio rectifying crystal?

A. 2. The only effect that a battery and potentiometer has upon the detector crystal is that it aids the high frequency current in the direction of least resistance. The sensitiveness is usually increased.

Q. 3. Give formula for determining the frequency of an oscillatory circuit.

A. 3. The formula generally used for determining the frequency of the oscillatory circuit is

$$n = \frac{1}{2\pi}\sqrt{\frac{1}{CL} - \frac{R^2}{4L^2}}$$

where

n=frequency in cycles,
C=capacity in microfarads,
L=inductance in centimeters,
R=resistance in ohms.

LIGHTNING SWITCH.

(557.) Harry Hexamer, Buffalo, N.Y., inquires:

Q. 1. When my detector is not in adjustment a noise similar to that of a high speed motor being started is heard in the receivers. There are no power lines near my aerial, and I use no battery in the receiving circuit.

A. 1. The only reason why you are hearing high pitch sounds is that a power station is somewhere near your receiving plant, and the sound heard in the receiver is most probably due to the current transmitted from the power plant to your in-

(*Continued on page 198*)

Eight Months Ago—

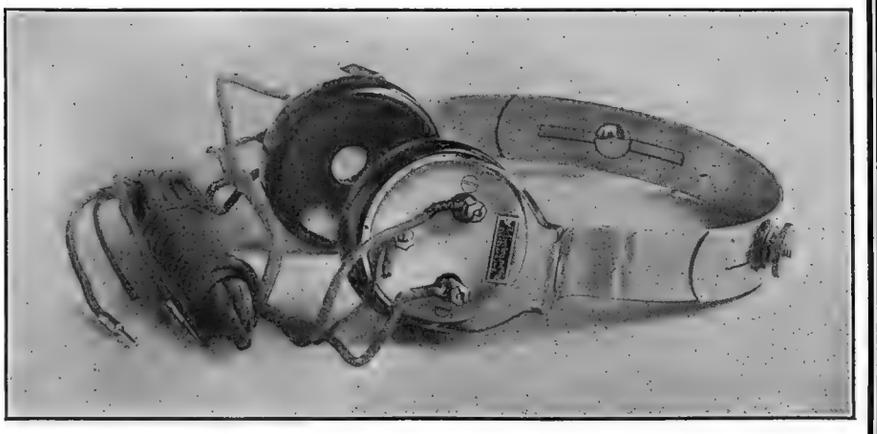
the Electro Set Co. determined to produce the finest wireless receiver head set that the radio world has ever known. The standard price of $5.00 per set, complete, was decided upon as being within the means of every serious experimenter. The trade name of "Red Head Receivers" was chosen for reasons that are described in our descriptive pamphlet.

THESE REMARKABLE RECEIVERS ARE NOW READY

No prospective purchaser of wireless phones can afford to buy until he has looked carefully into our proposition. Space does not permit us even to attempt a description of these wonderful receivers in this advertisement. But we have prepared a most interesting little story about these phones. We want to send you your copy at once. Send us *today* your name and address on a postal card. Your time will be rewarded by return mail when you will receive our interesting booklet:

"THE STORY OF RED HEAD RECEIVERS"

It's yours for the asking. You can't afford to miss it. Send *now* for the complete story and description of the most remarkable wireless receivers ever marketed. Better still, send for our complete Handy Book and Catalogue, just out, described below. We'll enclose a copy of "The Story of Red Head Receivers."



Our Handy Book and Catalogue

A book every experimenter should possess. Describing positively the finest and most complete line of wireless apparatus and experimental goods ever listed in any catalog and containing besides innumerable tables, hookups and treatises of inestimable value to the experimenter.

By actual comparison the Electro-Set Handy Book contains more information than **any two** twenty-five cent books on the market. We spent $9,000.00 getting this work ready for you, yet, notwithstanding the tremendous cost involved we ask that you send us only 10 cents in stamps or coin along with your request. This trifling fee barely covers the cost of mailing and handling the handy book, and is asked merely as a sign of your good faith and interest, as you will appreciate that we would hardly care to distribute the handy book at random. Send for the handy book today without fail. You will like it!

Note: Positively no Handy Book sent when 10 cents does not accompany request.

BARGAINS

Quantities are limited, so send your order at once

No. 11 E-2. TELEPHONE RELAY MAGNETS

In perfect condition. Resistance about 600 ohms. Size 3½ inches long, ¾ of an inch in diameter. Core drilled and tapped at one end for 8-32 machine screw. Fibre ends, Norway core. Heavy rod contacts. Wound with No. 36 pure silk covered copper wire. Worth $0.40. Shipping weight 1 pound for three, postage extra. Our special price until sold **3 for $0.25**

(*Not less than three sold.*)

No. 11 E-3. TELEGRAPH RELAYS

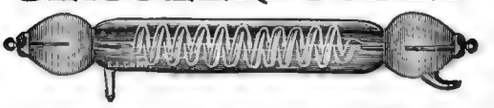
About 500 on hand. They need "fixing-up," but the coils, etc., are in perfect shape. You will have to supply the contact points yourself. Use brass, silver, platinum or copper wire for this purpose and you will have a first rate relay for experimental work. These relays are worth $3.00 each when new. The parts alone are worth $2.00 to any experimenter. Four fine binding posts, two splendid rubber encased relay magnet coils, armature, set screws and lock nuts, mahogany base with cast metal sub-base, tension post, etc. Any experimenter can readily put one of these relays into working shape in an hour or else he can find countless uses for the interesting parts. Shipping weight 3 pounds. Postage Extra. Price while they last, each **$0.48**

The Electro-set Co.

1874 E. 6th St., Dept. E-2 Cleveland, O.

RARE BARGAINS IN

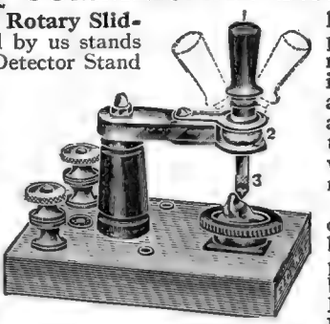
GEISSLER TUBES



Here is offered what is to our knowledge the only supply of real imported Geissler tubes in the country. To say this is an unusual offering is putting it mildly. These tubes are of the fluorescent liquid type only and the colors they show and the effect they produce when run on even a half inch spark coil or a static machine is certainly beyond words to express. If you really want to have something worth while get some of these tubes while the supply lasts. **Remember — this is the only stock in the country and no more can come in until the war is over.** The colors and shape vary in each tube, so that hardly two are alike. They should be ordered by express to avoid breakage. Only sizes shown are in stock.

No. 1126, Fluorescent Liquid Geissler Tube, 20 c. m. long sh. wt. 1 lb. ..... **$0.60 each**
No. 1127, Fluorescent Liquid Geissler Tube, 25 c. m. long, sh. wt. 1 lb. ..... **.70 each**
No. 1128, Fluorescent Liquid Geissler Tube, 30 c. m. long, sh. wt. 1 lb. ..... **.80 each**
No. 1128A, Fluorescent Liquid Geissler Tube, Length 11½ inches, sh. wt. 2 lbs. ..... **1.25 each**

THE ELECTRO COMMERCIAL DETECTOR STAND



With ½ inch Italian Marble Base and Rotary Sliding Cup. This instrument lately perfected by us stands in a class by itself. It is the highest grade Detector Stand ever introduced in the United States. It will appeal to all who wish a high grade instrument at a reasonable price.

Specification: Heavy marble base ½ inch thick, size 4½ x 3 inches; Hard Rubber Pillar, on which is supported a nickel plated casting, which holds the ball swivel 2. As will be noted, the handle, 1, may be moved sideways in any direction on account of the swivel-ball arrangement; a feature not found in any other detector. This is quite an important feature, as it is often necessary with certain substances to "feel" over the surface in order to find the most sensitive spot.

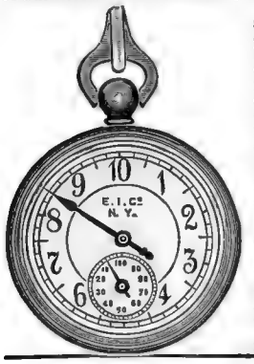
The handle, 1, **can also be pulled up vertically,** as it is held back by a spring inside of the ball. Any amount of tension of the spring may be had by adjusting knurl, 3. **This gives to the contact point on the detector substance any required tension.** Therefore this detector is capable of the greatest variations, not alone in its free movement, but it can be adjusted **from the lightest contact to the heaviest.** We also equip this detector with a phosphor bronze spiral for use with minerals requiring light contacts.

Only the best materials are used in the construction of this detector, all metal parts being finely nickel plated and highly polished. There are two heavy nickel binding posts and there is a **FELT COVERING ON THE BOTTOM OF THE MARBLE BASE.** Hugonium (soft metal) to set the crystal is also supplied. All 4½ x 3 x 5 inches.

No. 9500 "Electro" Commercial Detector Stand, as described. Price $2.00
Shipping weight 2 lbs.

THE AMERICAN PEDOMETER

No doubt you walk a great deal. Not only do you walk for pleasure or business but in the ordinary routine of life.



How far do you walk? You don't know and can't realize unless you carry an American Pedometer. Just hook it in your belt or slip it in your pocket and at the end of the day there is a surprise in store for you. The Pedometer has recorded your every stride upstairs, downstairs, up hill, down hill and on the flat. The Pedometer is adjustable without tools to any size stride from 15 to 41 inches long. Simply measure size of one stride from heel to heel and set the pointer back to that figure. Pedometer **NEVER NEEDS WINDING** and reads from 1 to 10 miles on large scale and 10 to 100 on small scale. Reads like a watch.

Finished in heavy nickel plate. Handy and interesting to everyone **but indispensable to the BOY SCOUT.**

No. 6717. American Hundred Mile Pedometer. . $0.80. Shipping weight 1 lb. **Absolutely guaranteed in every respect.**

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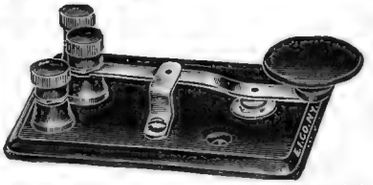
The Unusual Wireless Mineral

The most wonderful of all crystals. More sensitive than Galena, more sensitive than ANY other crystal or mineral.

The mineral that looks like liquid gold. Now in use by several governments. Equally sensitive all over. Used with a medium stiff phosphor bronze spring. Does not jar out easily. *Sold by the piece only.* Each crystal is tested and guaranteed. Each packed separately in a box. Money refunded if our claims are not substantiated.

Generous piece of tested Radiocite, $0.50 Prepaid.
We are the sole American Retail Agents for Radiocite
IMMEDIATE SHIPMENTS. NO DELAY.

THE ELECTRO TELEGRAPH KEYS



A new departure in telegraph keys. There has long been a demand for a good, efficient, but cheap telegraph key and the one which we are now manufacturing complies with all demands that anyone could possibly make of a low price key. The parts are mounted on a solid hard rubber composition base, size 2½ x 3½ inches, ¼ inch thick. All metal parts are nickel plated and polished and the contact arrangement is simple but absolutely sure. A standard telegraph knob 1 inch in diameter in hard rubber composition is furnished.

The No. 1118 Key has two of our standard rubber binding posts, while the No. 1119 has three of them. This key works easily and there is nothing to get out of order. It will make a handsome addition to any instrument table.

No. 1118 Single Circuit "Electro" Telegraph Key composition base, as described $0.35
Shipping weight 1 lb. **No. 1119 Double Circuit (Morse) "Electro" Telegraph Key composition base. . . $0.40**
Shipping weight 1 lb.

When ordering any of the above goods always include sufficient money for postage else we will ship by Express collect
"EVERYTHING FOR THE EXPERIMENTER"

THE ELECTRO IMPORTING CO., MFRS. **236 FULTON STREET NEW YORK CITY**

GOODS YOU NEED TODAY

"Electro" Magnets

For Sounders, Bells, Relays and Wireless Instruments, etc. Illustration ½ size. (Patented Dec. 20, '10.)

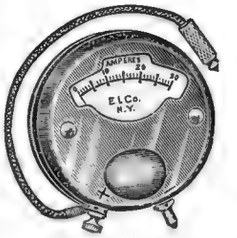
Our "Electro" Magnets are well made with fibre ends. Copper wire used being double cotton covered. Magnets are covered with mottled paper. The core is of very best soft Norwegian iron, and each core at the top has a silver contact riveted into same as shown, which may be used for making contact. This is an important feature patented by us and serves to make a contact which of course eliminates another contact arm or standard.

Size over all 15–16 by 1½; diameter of core ⅜ inches. Three styles carried in stock.

No. 01107 "Electro" Magnet, 20 ohms.....$0.15
No. 01108 "Electro" Magnet, 50 ohms..... .18
No. 01109 "Electro" Magnet, 75 ohms..... .20

Shipping weight, each style, 2 oz.

The "Electro" Pocket Volt and Ammeters



No. 4300

These little instruments are without doubt the most compact and durable meters ever produced in this country. They are not alone extremely accurate, but they are also "dead beat," all metal construction. The finish is the finest ever seen on a domestic instrument. Permanent magnet type indicates polarity as well as current. **GUARANTEED FOR 1 YEAR.** It is the smallest meter made, diameter 2¼ inches, net weight 4½ oz. Flexible, detachable lead, with contact pointer furnished free. Range of voltmeters, 8 volts, ammeters, 30 amperes.

No. 4300 "Electro" ammeter, as described, each..$0.80
No. 4301 "Electro" voltmeter, as described, each.. .90

Induction Coil Core Wire

The finest Swedish iron wire made

An unusual opportunity and a quick buy of some real soft double annealed Swedish iron core wire enables us to offer this wire now. Wire is perfectly straight and ready for use. Can only be supplied in lengths shown. The finest quality wire you can possibly use for making spark coils, open core transformers and audion amplifying coils. This wire is worth more at wholesale than what we offer it to you for. Remember real Swedish iron core wire is very scarce in the market these days and only the Swedish iron wire will give you the results you must have.

Comes in lengths only of 6", 16", 18", 20", 22".

No. 529 Swedish Iron Core Wire, per lb.....$0.15

Shipping weight is 1 lb. more than weight ordered.

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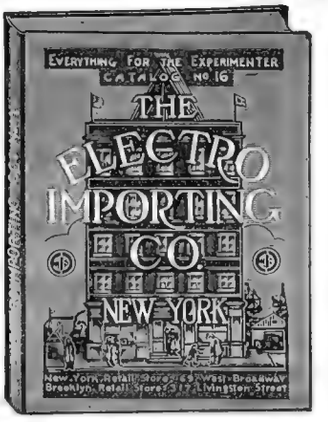

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Name.....
Address.....
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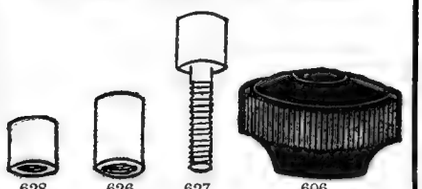
Switch Points and Knobs
For that New Set You are Making



628 626 627 606

SWITCH POINTS

	Doz.	50	100
628—¼" x ¼"—6/32	$ .30	$ .90	$1.50
626—¼" x ⅜"—6/32	.30	1.00	1.75
627—¼" x ¼"—½" shank	.36	1.25	2.00

601 602 608

KNOBS

	Each	Doz.
601— 8-32 Bushing	$ .04	$ .40
602— " "	.10	1.00
606— " "	.20	2.00
608—10-32 "	.05	.50

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New Undamped Wave Coupler No. 749
Special Introductory Price $18.00

32 in. long, 10 in. high, 9 in. wide, over all. On average sized Aerial, tunes to 15,000 meters. Used with the new CHAMBERS CIRCUIT, will bring in signals from all Local and Long-distance Undamped Arc Stations without the use of Loading Coils or Oscillating Coils as they are sometimes called. Lose no time placing your order, or you will miss a great offer.

CHAMBERS CIRCUIT is entirely new, and think of it! no extra Coils to pay for, and price of Coupler only $18.00. Write for descriptive matter.

F. B. CHAMBERS & CO.
2046 Arch St. Phila., Pa.

8,000 MILES
is the record (amateur) with our Audio-Tron Detector.
THE AUDIO-TRON
DETECTOR—AMPLIFIER—OSCILLATOR
Price postpaid $5.50
Jensen Electric Co.
RADIO APPARATUS and SUPPLIES
SEND STAMP FOR CATALOG
1949 Huron Street CHICAGO, ILL.

25c WATT **"WIRELESS" TRANSFORMER $15.00**
Closed Core Type Self Contained **14,000 VOLTS** 3 Different Powers Shipping Weight—20 lbs.

Folders and information descriptive of these ¼ K. W. transformers may be had for the asking—also of our 500 and 750 watt capacities.

Winger's Code Charts—large size **Continental—Post Paid—15c.**, small or pocket size **10c.** They enable you to learn the code **More Quickly** than by any other method.

Our New Detector (cat whisker type) is **"Some" Detector**—it is a marvel of simplicity and dependability—base is of **Vulcanized Fibre** and is furnished with **Two** crystal holders—one **Cupholder** and one **Looped Spring** holder—**Post Paid 50c. WINGER ELECTRIC & MFG. CO., 711 So. Dearborn St., Chicago, Ill.**

Boost
The Electrical Experimenter
to your friends
It will make your magazine better

QUESTION BOX.

(*Continued from page 195*)

struments by induction. The transmission of power is effected through the ground as the dynamos are grounded. It is not necessary to use a detector or other instruments to detect this current, as a pair of ordinary 'phones connected to a ground conductor will be sufficient for detecting it.

Q. 2. Can you give me the approximate amperage drawn by an arc light, using a water resistance on a 110 volt A.C. 25 cycle circuit?

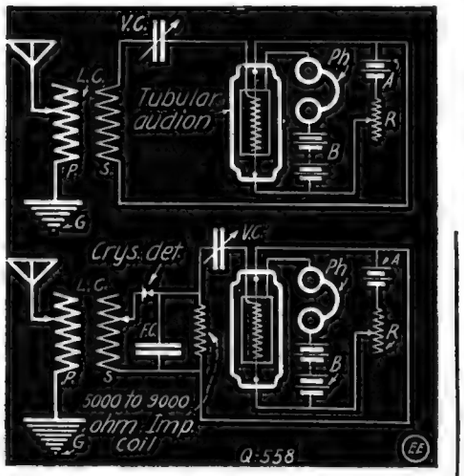
A. 2. It is impossible for us to give you the approximate amperage drawn by a 110 V.A.C. 25 cycle arc lamp, using a water resistance; the dimensions of the arc electrodes and resistance are necessary before we can tell you the number of amperes that the arc consumes.

Q. 3. Will copper bar ⅛" thick and 1" wide safely carry 100 Amp. and be heavy enough to use in constructing a lightning switch?

A. 3. The size of your copper bar is just right for constructing a lightning switch and will readily carry 100 amperes. Usually 1000 to 1500 circular mils are allowed per ampere.

TUBULAR AUDION HOOK UP.

(558.) Rolland Griffith, Monticello, Iowa, wishes:



Above: Connections for Tubular Type Audion Detector in Radio Receiving Set. Below: Tubular Audion Hooked Up for Amplifying Signals from Crystal Detector.

Q. 1. To have a hook-up for a tubular type audion, with a loose coupler, condenser and 'phones.

A. 1. The upper diagram gives the connections of the tubular type audion, loose coupler, condenser and telephones.

Q. 2. Can the type T tubular audion be used as an amplifier and if so will you please give me the correct hook-up?

A. 2. The type T tubular audion can be used as an amplifier by connecting it as in lower diagram.

Q. 3. Which is the best way to use this audion as an amplifier with a mineral detector or simply as a detector?

A. 3. The best way to connect the audion tube as an amplifier is with a crystal detector.

COMPOSITE ALTERNATOR.

(559.) Frederick Richards, Hartford, Conn., wants to know:

Q. 1. What is an alternator of the composite type?

A. 1. A composite alternator is similar to a compound wound D. C. dynamo, in that ia has two field windings. In addition to the regular field coils which carry the main magnetizing current from the exciter, there is a second winding upon two or upon all of the pole pieces, carrying a rectified current from the alternator windings which help to strengthen the field to further balance the losses in the machine.

Q. 2. What causes the lag of current behind the electro-motive force?

A. 2. The self-inductance of the circuit causes the current to lag behind the E.M.F. This may be remedied by adding capacity to the circuit, which has a tendency to make the current lead the electro motive force.

HORSE-POWER OF BELTS.

(560.) John Hanaon, Philadelphia, Pa., inquires:

Q. 1. How many horse power will a belt transmit?

A. 1. The capacity of a belt depends on its width, speed and thickness. A single belt (3/16" thick), one inch wide and traveling 1,000 feet per minute, will transmit one H.P.; a double belt (relating to greater thickness), under the same conditions, will transmit two H.P.

Q. 2. What width double belt will be required to transmit 50 H.P. traveling at a speed of 3,000 feet per minute?

A. 2. $W = 50 \div \left(\frac{3000}{1000} \times 2\right) = 8.33$

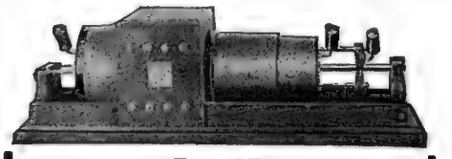
Thus the width of belt, W, required to transmit fifty H.P. is 8.33 or about 8 inches.

MARCONI NO. 7777 PATENT SUIT.

(561.) Raymond Haskell, Scranton, Pa., writes:

Q. 1. Can you tell me anything about the Marconi No. 7777 patent and the suit brought against the British Radio Telegraph and Telephone Co., Ltd.?

A. 1. The defendants contended that they had not infringed the patent and that the patent was not valid, and in support of their contention cited numerous documents and



Type AML

The Precision Varicoupler

Patented Mar. 7, 1916, foreign patents pending.

Up-to-date receiving circuits require improved apparatus. You can't get supersensitiveness with old style couplers. The Precision Varicoupler is PERFECTION in receiving tuners. It has

No Taps	**No Sliders**
No witches	**No Delicate Parts**
No "Dead Ends"	**All the Wire in**
No Contacts	**Use all the Time**

and is finished in mission oak, genuine cut hard rubber, silver finished wire, etc.

5 Styles, $10 to $25

For detailed information write for bulletin PL.

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18"x6½"x6⅞" .75 ea. 18"x7½"x7⅞" .75 ea.
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called no less than seven witnesses, besides citing eight patents in their favor. In support of their contention of non-infringement the defendants argued that a two-coil transformer was an essential feature of Marconi's selective resonance tuning scheme involving coupling, that they were using a one-coil or auto-transformer, and that an auto-transformer was not a known equivalent of a transformer at the date of the patent. Further they argued that if the auto-transformer they were using was an infringement they might instead use a single coil with an equal number of turns in each circuit which would not even be an auto-transformer and therefore could not infringe. The case was argued before Mr. Justice Parker in the Chancery Division of the High Court of Justice in London, December 12 to 21, 1910, and January 11 to January 20, 1911, and the judgment handed down by Justice Parker sustaining this famous patent says in part:

"It is contended that an auto-transformer such as the defendants are using was not a known equivalent of a transformer at the date of the patent and further that they might use an inductive shunt which would not be a transformer at all. I cannot conceive, however, that an electrical engineer in, say, 1899, woud have had any doubt that what could be done by a two-coil air core transformer could also be done by an air core auto-transformer, and this even if arranged one to one, although an inductive shunt had never been used as a transformer before. In my opinion, however, the use of a two-coil instrument is not an essential feature of Marconi's invention at all, and it is a matter of indifference whether a transformer or an auto-transformer be used.

"Being of opinion that every claiming clause of Marconi's Patent of 1900 is a claim for an entirely novel combination producing, an entirely new and useful result, and that the use of a two-coil transformer is no essential part of his invention. I hold that the defendants who in my opinion have taken all the essential parts of the invention, are infringers, notwithstanding that they have substituted an auto-transformer for a transformer in the combination claimed, and notwithstanding that the use of an auto-transformer with an air core for any such purpose as that for which Marconi has used the transformer may have been new.

"The action, therefore, in my opinion succeeds."

The plaintiffs were granted a certificate of validity of their patent and an injunction, costs and damages against the defendants. The defendants did not appeal.

DEFINITION OF PULSATING CURRENT.

(562.) Peter Lansing, Detroit, Mich., asks:

Q. 1. What is a pulsating current?

A. 1. A pulsating current always flows in the same direction, but changes its strength, not necessarily falling to zero, but usually rising and falling a constant amount.

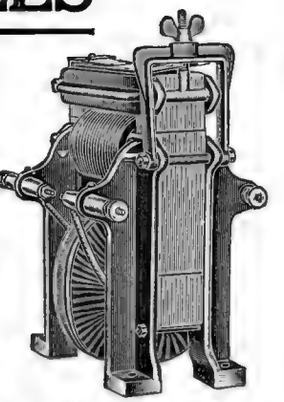
Q. 2. Is there any difference between the current obtained from a dynamo, and that from a battery of equal voltage?

A. 2. The current produced by a battery is steady, while there is a slight pulsation in the current obtained from a dynamo, even if it be a direct current machine.

Q. 3. Explain the meaning of a circular and square mil.

A. 3. The circular mil is the unit used in measuring the area of conductors. One circular mil is the area of a circle that is .001 inch in diameter. A square mil is a unit of area, being the area of a square .001 inch on each side. Circular mils times .7854 gives the square mils area of a round wire or square mils divided by .7854 gives the circular mils area.

YOU CAN "SEND" 1000 MILES



Make your wireless reach greater distances —transmit hundreds of miles further—with a THORDARSON WIRELESS TRANSFORMER. We constantly receive news of unusual distances attained with the aid of the THORDARSON—often as high as 1000 miles. Gives a stronger, steadier spark, instantly adjusted **without disconnecting transformer or cutting off current.** Amateurs everywhere are getting the best results with the

THORDARSON

WIRELESS TRANSFORMER

Magnetic Shunt makes possible instant adjustment of current **while sending,** just like the big commercial stations. Yet the THORDARSON costs only half as much as the open-core type. **Wonderfully flexible,** easily attains resonant condition. No impedance or choke coils needed. Assembled in heavy black enameled iron frame, shunt yoke adjustment in cast brass. Secondary terminals of polished hard rubber with brass core for easy adjustment. ½, ¾ and 1-KW. capacity, standard winding for 100-120 volts, 60-133 cycle. Special windings to order. *Write today for illustrated folder.*

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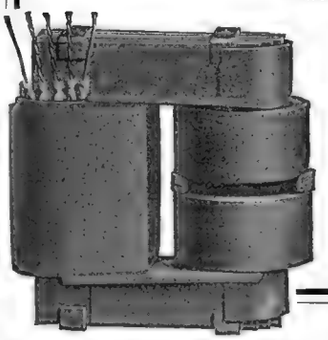

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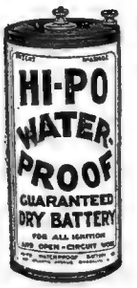

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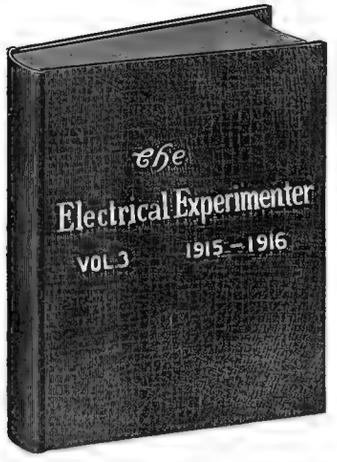

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SYNCHRONIZING ALTERNATORS.

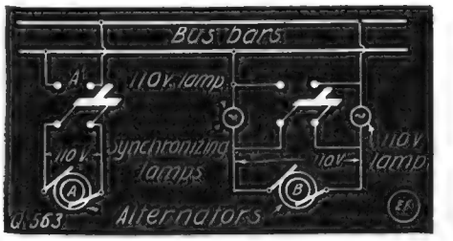
(563.) John Hattres, Cleveland, Ohio, asks:

Q. 1. How are alternators synchronized?

A. 1. The synchronizm of alternators is determined by some form of synchronizer, such as the lamp method connected as in the diagram.

Q. 2. How is the lamp method used for synchronizing alternators?

A. 2. Referring to the diagram, assume machine A to be in operation, then B is brought up to approximately the proper speed and voltage. When B is run a little slower or faster than A, the synchronizing lamps will glow in beats. At the instant the pressures are equal and the machines are in phase the lamps will become dark, but when the phases are in quadrature the lamps will glow. Since the flickering of the lamps is dependent upon the difference in frequency, the machines should not be thrown in parallel while the flickering exists. As the incoming alternator approaches



How Lamps Are Connected for Synchronizing Two A. C. Generators

synchronism, its speed is adjusted to slow down the flickering, and when this becomes very slow the incoming machine may be thrown in at the moment the lamp grows dark, by closing the main line switch. The machines are then in phase and tend to remain so. Close the main switch as nearly as possible in the center of a dark period.

GAS BATTERY.

(564.) John Jones, Paterson, N.J., wishes to know:

Q. 1. What is a gas battery and name one, if such exists.

A. 1. The simplest one is that of Grove, who arranged a platinum electrode so that it dipped in acidulated water, and also was in contact with a gas. When one electrode was placed in hydrogen and the other in oxygen, he obtained nearly one volt. Many attempts have been made to develop a commercial battery on this principle, but none have proven successful. These cells

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Pittsburgh Wireless Equipment Co.
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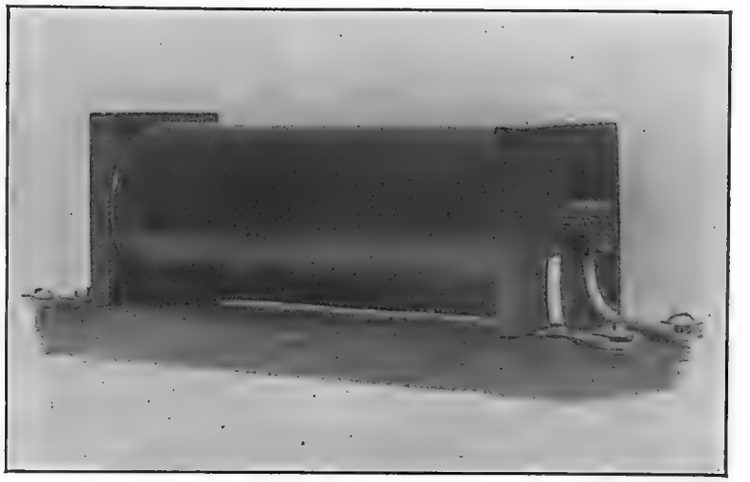
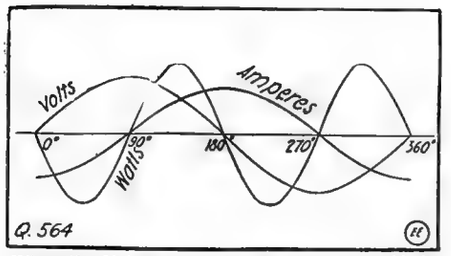


give a high theoretical efficiency and may some day prove to be the basis of a more economical source of power than the dynamo.



When the Voltage and Current Waves are 90 degrees apart, the energy is wattless as indicated

Q. 2. How can an alternating current be *wattless* or without energy?

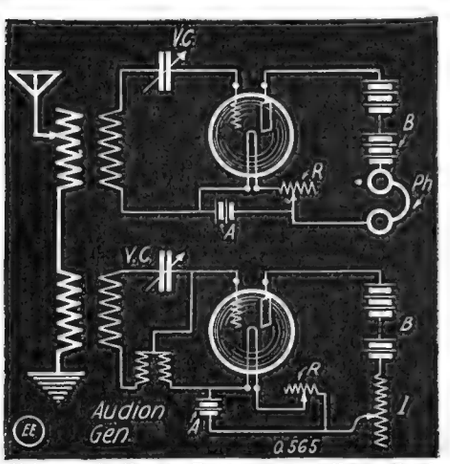
A. 2. This would occur in the extreme case when the current and E.M.F. curves are 90 degrees apart; one being at zero when the other is at a maximum, as indicated in the diagram. The negative loop in the watt curve exactly equals the positive loop, and the line returns as much energy as it receives. This extreme condition never happens, but is closely approximated when a circuit has a great self-induction and small capacity, as in the case of the primary coil of a transformer, when the secondary circuit is open.

WAVE LENGTH.

(565.) John McGraw, Jacksonville, Fla., asks:

Q. 1. What is the wave length of my aerial composed of four wires, 150 feet long and 80 feet high?

A. 1. The wave length of your aerial is 430 meters.



Using an Audion to Produce "Beats" in a Radio Receiving Circuit for the Reception of Undamped Waves

Q. 2. What size copper wire is required to deliver current at 110 volts to a 10 H.P.

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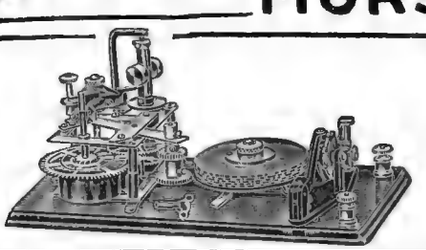

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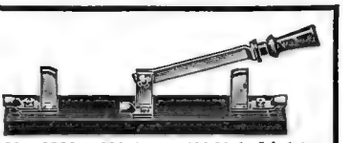

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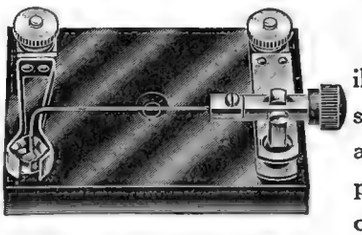

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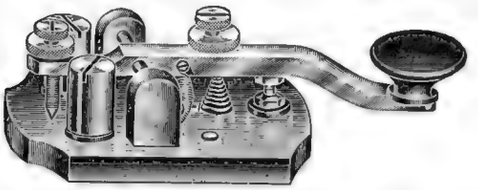

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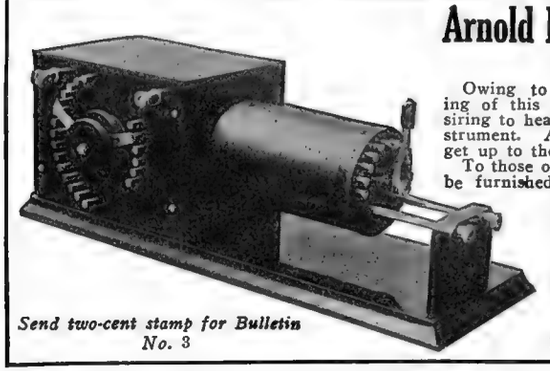

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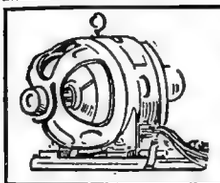

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motor of 85 per cent. efficiency; the motor being 2,000 feet from the generator and the electro-motive-force across the dynamo terminals being 125 volts?

A. 2. The proper size copper wire needed for carrying successfully the above load is No. 0000 B. and S. gauge.

Q. 3. Please give diagram of Fessenden's heterodyne receiver, using the oscillating audion as a generator for the high frequency current, utilizing a separate audion as a detector?

A. 3. The diagram gives the proper connections.

STANDARD RADIO TERMS DEFINED.

Approved by the Institute of Radio Engineers.

Under this head we will define the most important radio terms each month. Save them and by pasting each in a book (properly indexed) you will have a handy radio dictionary.

35. *Condenser, Air:* A condenser having air as its dielectric.
36. *Condenser, Compressed Gas:* A condenser having compressed gas as its dielectric.
37. *Conductor, Cage:* See Cage Conductor.
38. *Corona:* See Brush or Corona Losses.
39. *Counterpoise:* A system of electrical conductors forming one portion of a radiating oscillator the other portion of which is the antenna. In land stations, a counterpoise forms a capacitive connection to ground.
40. *Coupler:* An apparatus which is used to transfer radio frequency energy from one circuit to another by associating portions of these circuits.
41. *Coupler, Capacitive:* An apparatus which, by electric fields, joins portions of two radio frequency circuits; and which is used to transfer electrical energy between these circuits thru the action of electric forces.
42. *Coupler, Direct:* A coupler which magnetically joins two circuits having a common conductive portion.
43. *Coupler, Inductive:* An apparatus which by magnetic forces joins portions of two radio frequency circuits and is used to transfer electrical energy between these circuits thru the action of these magnetic forces.
44. *Coupling:* See Coefficient of Coupling (inductive).
45. *Current, Damped Alternating:* An alternating current whose amplitude progressively diminishes. (Also called oscillating current.)
46. *Current, Forced Alternating:* A current, the frequency and damping of which are equal to the frequency and damping of the exciting electromotive force. See further Current, Free Alternating.
    Note 1: During the initial stages of excitation, both free and forced currents co-exist.
47. *Current, Free Alternating:* The current following any transient electromagnetic disturbance in a circuit having capacity, inductance, and *less* than the critical resistance. See further, Resistance, Critical.
48. *Curve, Distribution, of a Radio Transmitting Station for a given distance:* This is a polar curve the radii vectors of which are proportional to the field intensity of the radiation at that distance in corresponding directions. See also Compass, Radio.
    Note 1: The distribution curve depends, in general, not only on the form of the antenna, but also on the nature of the ground surrounding the station.
    Note 2: The distribution curve generally varies with the distance from the station.
49. *Curve, Resonance, Standard:* A curve the ordinates of which are the ratios of the square of the current at any frequency to the square of the resonant current, and the abscissas are the ratios of the corresponding wave length to the resonant wave length; the abscissas and ordinates having the same scale.
50. *Cyclogram:* See Characteristic, Dynamic.
51. *Cyclograph:* An instrument for the production of cyclograms.

The Bell Telephone Company on February fourteenth successfully opened the Montreal-Vancouver telephone line, said to be the longest ear-to-ear circuit in the world. The line is 4,227 miles long, while the New York-San Francisco line recently opened is but 3,400 miles in length. The new line does not go direct through Canada, but runs via the following connecting points:—Buffalo, Chicago, Omaha, Salt Lake City and Portland, Ore.

PATENT ADVICE

Edited by H. GERNSBACK

In this Department we will publish such matter as is of interest to inventors and particularly to those who are in doubt as to certain Patent Phases. Questions addressed to "Patent Advice" cannot be answered by mail. Sketches and descriptions must be clear and explicit. Only one side of sheet should be written on. No attention given to unsigned communications.

PATENT APPLICATIONS.

(74.) J. Collins, Middletown, Conn., would like to know if it is advisable to make more than one application for patent at one time, to one attorney, or if it is best to wait till one invention is filed before proceeding with the other. Furthermore, he wishes to know if the bayonet lock is public property.

The first question is not quite clear to us. If you make one specific invention, you should of course only use one attorney to apply for the patent, for it is self-evident that you cannot patent the same invention more than one time. If you meant that you have several inventions, all different from each other, we would advise that any patent attorney can handle them at the same time and they could all be filed the same minute for that matter, as long as they are all different inventions.

The bayonet lock is a public property today.

LOOSE COUPLER.

(75.) Peter Haas, Indianapolis, Ind., wishes to know if loose couplers are patented apparatus and if anyone can make them to sell.

Loose Couplers are practically public property as the general principle on which a loose coupler is built is nothing but a *transformer,* the patent of which has expired years ago. Of course, there are all kinds of loose couplers and there are some forms of Couplers that have been patented. The ordinary coupler, however, is not patented and anyone has the right to make and sell it.

COMBINATION ICE TONGS.

(76.) Cyril Puderer, Belleville, Ill., submits a sketch and description of ice tongs and wishes to know our advices as to its patentability and practicability.

As far as we have ascertained this is quite an original invention and we are almost certain that a patent can be obtained upon it. It is a very ingenious instrument and will certainly save a lot of time by combining several tools into one. Would advise correspondent to get in touch with a patent attorney at once.

TALKING-MOTION PICTURES.

(77.) C. O. Hasselberth, Seward, Neb., submits description and illustration of an idea to combine motion pictures with loud-speaking telephones. He wishes to know if the invention is original and whether it can be patented.

We see nothing new in the idea submitted to us, and furthermore the device will not run satisfactorily, because it is impossible for the two devices to always run in synchronism; that is, we cannot see why the loud-speaking telephone wi not run ahead or otherwise lag behind the motion picture production. Schemes of this kind have never proved very satisfactory and even the best ones are too expensive for everyday use in motion picture theatres. This problem of synchronism is a very serious one, as it should be realized that devices of this kind must absolutely work in unison. It is self-evident if one reflects for one second, that it is bad business for instance in a certain film to have a person shot dead and the report comes either two seconds too soon or two seconds too late. The entire success of schemes of this kind are naturally centered upon synchronism and to this date nothing *that works really well, all the time* has been evolved.

SELF-ADJUSTING MONKEY WRENCH.

(78.) F. L. Conlin, of Kenilworth, Ill., sends sketch and description of a self-adjusting monkey wrench and desires to know whether we think it is practicable and patentable.

There is a very similar monkey wrench to the present one on the market already, and we are not quite sure whether a patent could be obtained. You had better take up the matter with a patent attorney to make sure.

RAILROAD TELEPHONE.

(79.) B. L., Cincinnati, Ohio, has several queries as follows:

(1.) Suppose a young man has considerable inventive ability, a fairly complete knowledge of electricity, some shop experience and a high school education with poor prospects of going to a university. Is there any possibility of getting employment in the Government laboratories or in those of any scientific institution?

We believe that the young man will have a good chance of securing employment and it is not absolutely necessary to be a college graduate.

(2.) Would you advise one to perfect an invention of his own while in the employ of a company?

When making an invention and developing it while you are employed by a company, you automatically lose the title to your invention and the right to exploit it goes over to the company who employs you. This means, of course, if you develop it in their time. If you work out your idea after working hours at home, all rights thereto belong to you.

(3.) Is a sign painted with sulphate of quinine and displayed under Geissler Tubes patentable? Our advice is—No.

(4.) As to another inquiry, which considers the placing of electromagnets under the cars of a moving train, and steel horseshoe magnets on each tie of the road bed, this idea, while it certainly will work, is entirely impracticable and too costly.

PATENTS

IF YOU HAVE AN INVENTION which you wish to patent you can write fully and freely to Munn & Co. for advice in regard to the best way of obtaining protection. Please send sketches or a model of your invention, and a description of the device, explaining its operation.

All communications are strictly confidential. Our vast practice, extending over a period of seventy years, enables us in many cases to advise in regard to patentability without any expense to the client. Our Hand-Book on Patents is sent free on request. This explains our methods, terms, etc., in regard to **Patents, Trade Marks, Foreign Patents,** etc.

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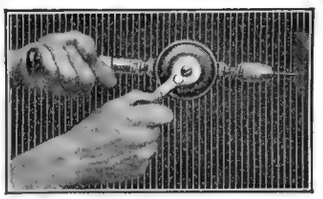

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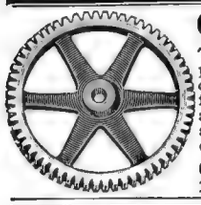

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MARKETING AN INVENTION.

(80.) Frederick R. Herman sends us a lengthy statement of how, for several years back he has perfected several inventions without being able to have them patented owing to shortage of funds. Moreover, he has not been able to put them on the market nor interest other people in backing him in order to manufacture the various devices. He wishes to have our advice.

We would refer our correspondent to query No. 70, published in the June issue of *The Electrical Experimenter*. This states the case very plainly. It costs but a few cents to protect an invention by writing it out on a sheet of paper and having it sworn to before a Notary Public. In such a case *priority* can always be shown and the original inventor is always protected.

As to securing capital for perfecting inventions, it is impossible to give any hard and fast rules on this subject. This is a matter of personality, pure and simple, for if the invention is at all good it should not be hard to interest someone with money in the manufacture of the device. There are always people on the lookout to invest money in something that is really meritorious, and as long as they can be shown that the invention is novel and reasonably profitable, they are willing to invest. Very often connections like this can be made by advertising the fact under "Business Opportunities" in the daily papers or the Sunday papers and many of them, particularly some of the New York Sunday papers, make a specialty of carrying this class of classified advertising. It is not costly and has very often resulted in finding just the right man. This is the only advice we can give on the subject.

MODERN RADIO TRANSMITTING APPARATUS.

(*Continued from page 174*)

is connected through a central metal rod. The efficiency of this type of gap is said to be far greater than the circular plate type, which is today extensively employed, and undoubtedly will replace the older form if it really proves more efficient.

A massive oscillation transformer is shown in Fig. 4. One coil has a sliding contact, while variation of the other is secured by clips, which can be moved and set up at different positions along the copper strip. The variation of the inner turns is secured by a trolley wheel contact, traveling along the inner edge of the copper strip conductor. The central shaft is also provided with a very coarse pitched thread, which insures an easy, free and certain movement of the contact along the conductor. Ample variation of coupling is provided by allowing the inner coil to move along its axis. The conductors of the oscillation transformer are made from strip copper, wound on edge, supported by properly spaced Bakelite strips. The complete unit is braced by four insulating standards as seen in the illustration.

Practically all ship transmitters of the old type are today being replaced by panel sets, as it has been found that panel outfits are more compact and give better service than the old forms of transmitters. A very compact and yet efficient panel transmitter is shown in Fig. 5. The front of the panel contains the indicating instruments, switches, control handles, quenched gap and motor for cooling the gap. The oscillation transformer is placed behind the panel as shown and this consists of the edgewise copper ribbon type. The turns are wound on an insulating conical form, which has been found the most efficient method of winding the ribbon to increase the efficiency of the transformer for a wide range of wave lengths. The secondary is built in the same manner as the primary. The coupling between the coils is varied by turning the outer handle of the front of the panel, while the number of turns are controlled by the larger handle. The condensers are mounted below the oscillation transformer, as can be seen. The motor generator and protective devices are situated below the condensers.

The Germans have lately developed a portable Poulsen arc outfit for military work, and it has been found that greater range and better service can be obtained by such a transmitter. The advantage of the arc transmitter over the spark type in military work is in secret code work, where it is necessary to transmit the messages in such a manner that the enemy cannot understand them. In the arc transmitter the frequency and the wave length can be instantly changed.

The latest type of Poulsen portable transmitter is shown in Fig. 6. The arc generator is illustrated at G. It consists of a standard type, employing a fixed carbon and revolving copper electrodes, placed between two powerful electro-magnets. These are excited by a powerful direct current. The magnets are supported by a specially designed iron yoke so as to give the maximum flux between the poles. The copper electrode is revolved by means of a small electric motor, placed beneath the central chamber. The gaseous atmosphere which is supplied to the arc is obtained from a compressed hydrogen gas tank, behind the arc proper. The choke coils are placed between the front of the machine and the current is fed through a plug and cord Kb, and which is regulated by rheostat W. Power for the electromagnets is obtained from a direct current dynamo, which also supplies the arc electrodes.

The oscillating circuit consists of a unique oscillation transformer S, the secondary of which is enclosed by the primary, while the coupling is varied by turning knob K. The primary contains two steps for changing the wave lengths, regulated by a plug. The separate coil at the left is used for additional loading. The air type condensers are located beneath the transformer. They are controlled by four switches H. The aerial circuit is taken from the secondary of the oscillation transformer, through the right hand plug switch A, while the ground circuit is obtained from the other terminal of the secondary, and through a milli-ammeter Am, a fuse block which is shown beneath the current measuring instrument, and finally through the left hand plug A. A certain number of reserve electrodes are supplied, which are seen in their container, Ko. The code symbols are formed by a back break key Ta. This is connected across several turns of the secondary coil of the oscillation transformer, the diagram of connections of which is practically the same as in the standard Poulsen arc circuit.

The complete unit is placed in a substantial cabinet, which is supported by four steel legs. The power generator which consists of a 550-volt D.C. generator, driven by a gasoline or oil engine, is also compactly mounted in a case, ready for instant service, and both of these cases are easily carried by a horse or mule. The time required for setting up the apparatus, ready for duty, is very small as compared with the present forms of military radio apparatus. The Germans have also developed a unique collapsible aerial mast, which is said to take about fifteen minutes to erect. It is approximately 100 feet high.

(*In the next installment we will bring a description of some of the modern radio receiving apparatus.*)

THE ELECTRIC FURNACE.

(*Continued from page 162*)

The Kiellin furnace, shown in Fig. 8 is probably the most popular and will be taken as an example. The metal to be smelted is placed in the trough, D. This trough encircles the leg of the transformer, C, and the metal to be smelted forms a single secondary. An alternating current of 90 amperes at a pressure of 3,000 volts is passed through the primary, A. This induces a current of 30,000 amperes at a pressure of 7 volts in the secondary. When the operation is completed the furnace is tipped and three-quarters of the charge poured out, the rest being left to form the secondary circuit when the furnace is again started. This furnace is used at Gysinge, Sweden, in connection with a process for the production of a high grade tool steel.

The electric furnace, photographed as the molten steel is being poured out, is rated at 750 K.W.

As a final consideration it may be well to mention that the commercial application of the electric furnace has reached a stage where it is no longer considered an experiment. Industry's firm stamp of approval is upon it and the names of those men who have done so much toward its perfection will go down in history as great uplifters of industrial science.

NEW TUNGSTEN MOLYBDENUM ALLOY SUBSTITUTES FOR PLATINUM.

(*Continued from page 165*)

guides, *H* and *I*. The briquet, *D*, is then placed in position on the lower electrode, *C*, after which the upper electrode is lowered to contact. The inverted cup, *F*, is then lowered into place, forming the chamber *E*, through which is passed an inert gas, swiftly at first, to expel the air, and then slowly, as indicated by a bubbler in the purification train. The upper electrode is movable and can be forced downward onto the briquete by taps from a hammer administered to its upper face. The briquete could thus be forged while heated by the electric current passing through the furnace, i.e., from the upper electrode to the lower one. The inventor made tiny briquets of these blends by submitting finely divided powder to a pressure of more than 300,000 pounds to the square inch. The briquet mold is illustrated at Fig. 2, and the Brinell hardness-testing machine, whereby the briquetes were compressed, is shown in Fig. 3. This machine gave very sensitive and accurate control up to a total load of 268,000 pounds per square inch. He placed these in the furnace and treated them to temperatures ranging from 500 degrees to 2,800 degrees C.—the highest temperature ever used in treating a metal—for periods of from one minute to one hour, and hammered them while hot.

The best results were obtained with pure tungsten and molybdenum, heated to 2,300 degrees C. for one minute, the crystals being fine and the ingot quite homogeneous. These were forged without difficulty. An alloy of tungsten and molybdenum half and half was produced in wrought form that gave excellent results. The appearance of a cross-sectional cut through one of these 50 per cent. alloy briquets can be judged from the microphotograph at Fig. 4.

Dr. Fahrenwald summed up the work by saying: "Except in two respects, pure ductile tungsten and, to a lesser degree, molybdenum, meet all of the specifications of a practical substitute for platinum and its alloys. These two defects are its ease of oxidation and the difficulty with which it can be soldered, and they have been overcome by coating with a precious metal or alloy, the resulting material being in many ways far superior to platinum or its alloys."

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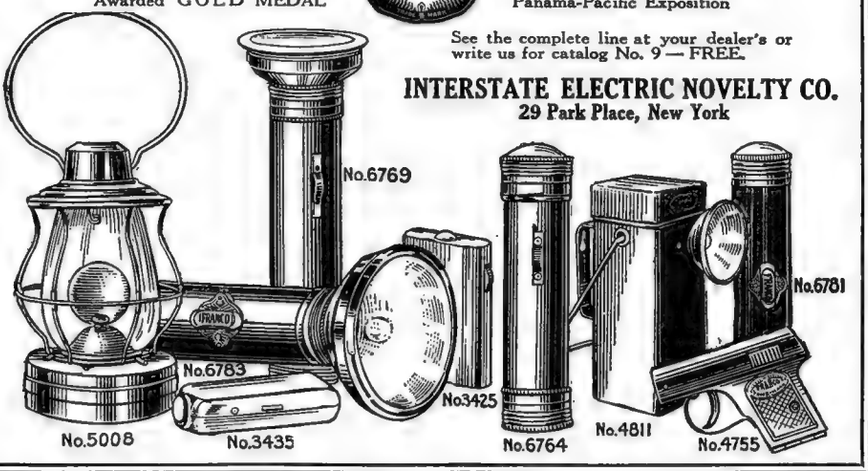

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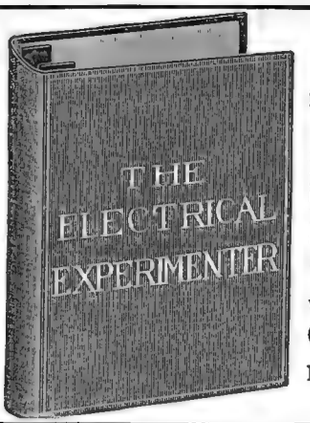

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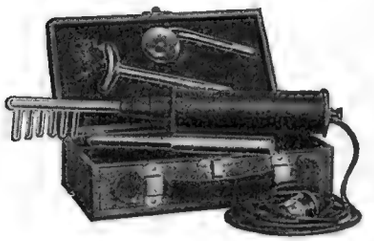

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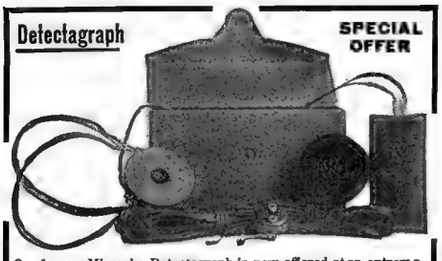

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Tungsten and molybdenum are not nearly so expensive as platinum. The former was quoted in December at $3,000 a ton for 60 per cent ore. It is now even higher. Molybdenum ore, which was $750 a ton before the war, was quoted in February at $3,600. These metals are necessary to the making of high speed tool steel, as they prevent it from losing its temper even when red hot. They are also in great demand by makers of artillery and ammunition. Prospectors are hungrily seeking deposits of tungsten ore. The world's largest deposit of molybdenum is located at Catherine Hill, in Hancock County, Me., it is said.

SOME POPULAR MISCONCEPTIONS OF MAGNETISM.

(*Continued from page 163*)

Such motors as those used for railway purposes are invariably, and have been for many years past, entirely inclosed in an iron carcase or shell, so that the magnetic leakage effect from same is very, very small indeed, and no such effect as just mentioned could possibly have taken place. If such motors as those shown at Fig 3 C were mounted on the car trucks with the field poles N and S pointing downward toward the road-bed, then the statement above made would have had some weight.

In conclusion it may be said while we cannot screen magnetism or cut off its effects as we would, for instance, a beam of light by means of a shutter, we can modify its action or control it by providing magnetic (iron) shunts, which is the principle of course involved in the attempt to shield the watch movement previously referred to. In the modern type of dynamo and motor there is very small magnetic leakage, owing to the ring form of the field frame and yoke. This must be prevented, and is so from an engineering point of view, for the reason that magnetic leakage of any magnitude worth speaking of spells loss of energy.

THE CONSTRUCTION AND USE OF THE GOLD-LEAF ELECTROSCOPE.

(*Continued from page 182*)

ford a rough measure of the quantity of electricity brought up by the proof plane, i. e., of the quantity of electricity in the source from which the proof plane itself was charged. In all of this work the proof plane must be actually touched to the top plate of the electroscope when charging the latter. This method is called *charging by contact.*

It is possible and often preferable to charge the leaves of the electroscope without actually touching the proof plane to the instrument. Charging can be effected by *induction.* It is quite clear how this is possible if we bear in mind the general law that *like charges repel one another and unlike charges attract one another.* It is only because of their similar charges that the leaves of the electroscope repel each other in any case.

Suppose that the instrument is uncharged. We can assume that it is neutral because there are an equal number of positive and negative charges scattered uniformly over its entire conducting surface, essentially as illustrated in Fig. 3. Now, if the proof plane or any other conductor bearing a positive charge is brought up to within a small distance of the top of the electroscope the charges will redistribute themselves in accordance with the law stated above, and their arrangement will be about as illustrated in Fig. 4. The negative charges will be attracted to the upper part of the wire, while the equal number of positive charges will be repelled as far as possible from the positive charge on the proof plane, and hence will be driven down into the gold leaves. The latter will diverge, because they now have similar charges, i. e., they are both charged positively. Keeping the proof plane in position, now touch one finger to the top plate of the electroscope. This immediately furnishes a connection to the earth, and the positive charges will entirely leave the instrument, flowing off to the earth because of the repulsive force of the equal positive charges on the proof plane. The electrical condition of the electroscope will be that illustrated in Fig. 5, for the negative charges will still be held to the upper part of the electroscope and the leaves will close together, because they are temporarily discharged. If the proof plane is still kept in place and the connection between the instrument and the earth broken by removing the finger, the distribution of the charges on the instrument will not be changed. However, if the proof plane is now removed the negative charges will be released from the attractive force that held them to the top of the electroscope and redistribute themselves more or less uniformly over the entire metallic part of the instrument, as shown in Fig. 6. The instrument has now been charged negatively by induction. The same process will suffice to charge the electroscope positively if the charge brought up on the proof plane is negative. In other words, when charging the instrument by induction, the charge obtained ultimately will be opposite in sign from that on the proof plane. This method is preferable to that where direct contact is used, in that the experimenter can be much more certain of the sign of the charge he has imparted to the electroscope.

For further ways of making use of the gold leaf electroscope the reader must be referred to the many text-books on elementary physics and electricity. However, all ordinary methods of using this instrument depend upon the principles that have here been outlined.

NEW ENGLISH INCANDESCENT ARC LAMP.

(*Continued from page 161*)

On switching off the current the electrode returns to its original position, having left the inactive part and coming to rest opposite the still active portion of the ionizer. By this means the lamp may be restarted at any period of its life without difficulty.

In this lamp practically the whole of the intense white light emanates from a small globule of fused tungsten 1/10 inch in diameter.

Filaments of ordinary incandescent lamps are always distributed round the stem and thus occupy a fairly large area, whereas in the new lamp the light-giving surfaces are concentrated in the center of the bulb. In the same way that a carbon lamp appears yellow in comparison with the ordinary half-watt tungsten lamp, so does the latter appear yellow when contrasted with the new incandescent arc. For high candle-power lamps the bulbs are much smaller than for metal-filament lamps of corresponding candle-power, e.g., electrodes to give 500 candle-power can be placed with safety in a bulb four inches in diameter.

The efficiency for the normal working current has a value of approximately 0.5 watt per International candle-power, or 2 candle-power per watt. The current may be increased until the tungsten reaches the sputtering point, at which the efficiency is about 0.3 watt per candle-power or 3.33 candle-power per watt. This certainly is a remarkable efficiency.

Lamps of this type have been made with a life of 500 hours, and it is hoped that fur-

ther experiment will make it possible to obtain a true half-watt lamp with a life of 800 hours and over. During life the average decrease in candle-power is about 10 per cent.

As compared with the carbon-filament lamp (3.5 watts per candle-power) with an intrinsic brilliancy of about 375 candle-power per square inch, and metal-filament lamps giving 1,000 candle-power per square inch, the intrinsic brilliancy of the new lamp at an efficiency of 0.5 watt per candle-power, or 2 candle-power per watt, is approximately 10,000 candle-power per square inch. The color of the light can be made to vary from a bright yellow, when running at low efficiencies, to a very intense white light, when the lamp is run to the sputtering point of the electrodes. The range of intrinsic brilliancy between these limits is approximately 400 to 30,000 candle-power per square inch.

THE MARVELS OF MODERN PHYSICS.

(*Continued from page 167*)

tion it gives to the electron theory of radiation makes it doubly valuable.

Faraday had, long before, investigated the spectra of different sources in a strong magnetic field, but had failed to obtain any results. Zeeman, however, used a powerful diffraction grating instead of a prism, and found that the spectral bands of any light broadened out under the influence of the magnetic field. This is strictly in harmony with the electron theory of radiation, for the field of the electron rotating in such a field would interact with it, so that when the fields oppose each other, the speed of the electron would diminish, and when both act together, the speed would increase, while when the electron was moving at right angles to the external field, its speed would not be affected. Instead then, of waves of a single length being emitted, other waves slightly longer and slightly shorter will also be emitted, depending on the speed of the electron. Thus the spectral band will be widened out, and, if the dispersive power of the grating is sufficient the band may separate into three parts known as triplets. If the light is viewed from some other direction with reference to the magnetic field, still different appearances may be presented.

Lorentz was the first to suggest that the electron itself generated the light wave, and it is apparent that this explanation is quite satisfactory. In addition, the above effects seem to indicate pretty clearly the existence of the free electron, and as we see it now, the conductivity of a metal must depend on the number of free electrons per unit volume, and their mean free path. From experimental calculation, it seems there may be five or six free electrons for every atom in a good conductor like silver, and other determinations do not vary greatly from this. Although the free electron theory of conductivity is still in the plastic state, as it were, it undoubtedly represents a degree of the true condition, and more careful study of the above phenomena will no doubt clear up many of these mysteries.

[*This is the sixth paper of a series prepared especially for The Electrical Experimenter by Mr. Rusk.—Editor.*]

WIRELESS PATENT TRIAL POSTPONED.

On Saturday, April twenty-ninth last, the attorneys for the complainant, the Marconi Wireless Telegraph Company, in the case of that company against the Kilbourne and Clark Manufacturing Company, asked for and secured a continuance of the trial until July eighteenth, on the grounds that it, the Marconi Company, had been in error as to the characteristics of the "Simpson" mercury valve transmitter used by Kilbourne & Clark when complaints were originally filed in Brooklyn and Buffalo, N.Y. Therefore, it developed that their engineers would require additional time, in order to make tests upon which to base their claims of infringement of the Marconi patent.

The K. & C. attorneys vigorously opposed the continuance and only acquiesced when the Marconi attorneys agreed that all expense incidental to the continuance would be paid by them.

The continuance was secured by the Marconi Company after the hearing had entered the seventh week, and Judge Neterer of the Federal Court had heard all the evidence against the defendant, the Kilbourne and Clark Manufacturing Company, who build the "Thompson" standard impulse transmitter and standard receiver.

EXPERIMENTAL CHEMISTRY.

(*Continued from page 187*)

flame of a Bunsen burner until it is "red-hot." Remove, let cool and examine. Observe whether it has changed to anything else besides iron. Does it look the same as before it was heated?

EXPERIMENT NO. 2.

Put about 5 grams of limestone ($CaCO_3$) into a *perfectly dry* test tube and heat in the flame of the Bunsen burner, keeping the tube in constant motion, and not letting the heat remain upon one spot for any length of time. Notice whether the limestone has changed to anything else. After the heat is removed, examine the substance in the tube. Apparently there has been no visible change, but the product which we now have in the tube is no longer limestone, but has changed to an entirely different substance called quicklime (CaO).

$$CaCO_3 = CaO + CO_2$$

Calcium Carbonate (Limestone)	Calcium Oxide (Quicklime)	Carbon Dioxide

EXPERIMENT NO. 3.

Put about 5 grams of sugar into a *perfectly dry* test tube and apply heat the same as in Exp. No. 2. Notice any changes. What do you notice on the sides of the tube? Are any gases given off? What do you see left behind? Add about 5 or 10 c.c. of water and see if it dissolves. Is this product sugar?

The same kind of treatment upon different substances may produce entirely different effects. In the above experiments we have applied heat to three entirely different substances. In all three we have obtained different results. In the first, namely the iron, there was no change effected. We still had iron, after it was allowed to cool.

In the second experiment there was apparently no visible change in the limestone ($CaCO_3$), but there was a most decided *invisible change*, causing the limestone to change to quicklime (CaO).

When heat was applied to the sugar it melted, darkened and charred, and became very evidently changed into more than one kind of matter; gases having the odor of burnt sugar went off, while a dark tarry mass was left.

Summing these three changes up, we find that the first experiment caused a physical change, from cold to hot. The second caused a chemical change, a new substance having been formed. In the third another chemical change has taken place. The tarry mass is no longer sugar, but an entirely different substance.

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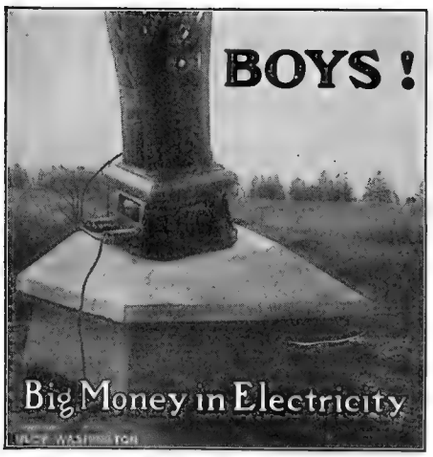

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MIMIC ATOMS AND THEIR EXPERIMENTAL FORMATION.

(*Continued from page 169*)

the immediate-force-field—and that is probably the simple explanation of a certain phenomenon of black body radiation that has given rise to the unnecessary theory of the atomization of energy. The phenomenon is, briefly, that a body does not radiate energy in a continuous manner, but in small parcels or lumps that are always a whole number of times the smallest lump which becomes, accordingly, the *atom of radiated energy*. It is when the word *radiated* is struck out of the last phrase that the view becomes untenable, because it seems that the body is well able to absorb energy continuously, but is restricted to giving it off in lumps. That is just the way our positive-ring atom ought to behave. The vibrations of its electron group will readily absorb energy from any appropriate source, but will practically refuse to give back any of that energy until the amplitude of the central bellying of the group begins to pass the immediate-force-field limits into parts dominated by the inverse-square-law of electrostatics; whereupon the center electrons will swing far out, and, with strong magnetic effect, radiate their energy.

Now to return to the rotating 8 ring. An electron entering an atom's immediate-force-field with not too much velocity and in a direction tangential, or across the axis of rotation of the positive ring, will tend to spiral back and forth through the plane of the ring. In an actual case the new arrival will give up the excess of its energy almost instantly to the atom's electron group. The latter will be set in rotation in its own plane and will consequently expand until its new centrifugal effort comes into renewed balance with the centripetal effort of the positive ring's field. Because of the mutual repulsions of the electrons composing the group, the latter's several rings are like so many cogwheels interlocking with one another, and must consequently rotate with the same angular velocity. In that case the linear velocity of the outer rings will be greater than that of the inner rings and the rotation will more greatly expand the outer rings than the inner rings, diminishing the pressure of the former upon the latter. The innermost ring and member will then be able to behave quite independently of the rest of the group. The innermost member, if there is such, and which is always a single electron—1 in the middle of the innermost ring, 5; or 1 in 6; or 1 in 7—will no longer be able to remain in its central position, but will wabble into rotation until it joins the innermost ring, provided that the latter does not thus become in excess of a certain *critical* number, and the evidence is that the number is 8.

Considering the simple groups we find by experiment, when they are at rest, that the groups 1, 2, 3, 4, and 5, form dot, line, triangle, square and pentagon, respectively; they do not require a member inside of them to hold them up. But the hexagonal group, 6, or any group larger than that, cannot be formed without putting a magnet or an electron inside of it to "hold it up." When there is just one electron inside of such a ring the latter may have 5, 6, 7, or 8 electrons, but it cannot have 9, or more than 9. Therefore, we see that it is a fact, in the case of a simple group at rest, that 8 is the number of electrons, or of magnets, composing the ring. This number cannot be exceeded when there is only one electron or magnet inside of the ring; and it seems that in the case of a simple group rotating at such velocities as may be by the conditions above cited, 8 is the number of electrons in the *rotating* ring which cannot be exceeded when there is *no* electron inside. In the case of the resting group, the addition of one more electron to the 8-ring, results in throwing the extra electron into the middle of the ring, making the group (2+8). Likewise, one electron added to the rotating 8-ring would be forced to the center of that ring, and from there it would soon be knocked out of the atom.

Therefore, with the limiting condition granted, one or more electrons entering atoms whose inner numbers are 4, 5, (1+5) and (1+6) will in a large majority of cases be caught and will be retained as a direct result of the rotations which they impart to the atom groups. Such electrons will be retained until enough of them have entered the respective atoms to form rotating 8-rings; any further additions will be thrown out and the atoms will become negative ions conforming in valency values to the *positive valency minus 8* rule. That is the explanation of negative ion valencies.

The explanation of the zero valency of, for example, the inert atom of neon is now simple. The group, (1+7+12), of neon is shown in Fig. 17. The inner number of electrons is (1+7). Sometime the whole inner number, or part of it, will be knocked out. When it returns, speeding up in that case under the powerful electrostatic pull, it will more often than in nine cases out of ten, set the neon group in rapid rotation. In this case much more difficulty will be encountered in again knocking the inner number out of the atom, and at the same time it will not be possible for another electron to lodge, because the rotating 8-ring will already have been formed. The result is an inert atom. That does not explain why some members of the combined zero-eighth family prefer one kind of valency and some the other. Experiments conducted in a large apparatus upon the groups of iron, nickel and cobalt suggest the reason, but we will leave the question open.

In general, the tendency to a positive ion valency is more widespread than the tendency to a negative ion valency, because it is easier and a much more simple operation to knock the insides out of an atom in collision than it is rotationally to assist an invading electron to remain.

There is a large body of atomic combinations in molecules where it is at first difficult to explain the valencies as ionic in nature. These are such compounds as are not dissociable by electrolysis, and molecules, such as the H_2 molecule of hydrogen gas, where it is very hard to believe that either atom can be, or at least can remain for any time, as a negative ion. An explanation of such a combination is given graphically in (11), (12), and (13) of Fig. 19. We have there the molecule, N_2, of nitrogen gas in process of formation. Incidentally it is well to remember that the nitrogen gas molecule is one of the most stable known. The snuffed-out lives of thousands of men on European battlefields readily attest that fact.

In this explanation we first see the inner number, 5, of electrons oscillating back and forth through the ring of a nitrogen atom and into and out of the immediate-force-field. The paths of the several electronic vibrations, as influenced by the mutual repulsions of the 5 electrons and by the changing attraction values of the positive ring, are probably sharp-nosed parabolas in the manner shown. Such an atom will be neutral only during the instants when its electrons pass through the ring. At all other times it will be a positive ion of 5 charges and will have, on one side or the other of itself, the 5 negative electrons. It will be like an insulated rod charged at one end with one sign and at the other end with the other sign. Two rods will attract one another in such manner as to

bring their unlike signs together. So, also, two atoms, when their charges are vibrating synchronously and one half wave length out of phase, will attract one another in a manner intended to consolidate all of the electronic vibrations into a continuous circulatory exchange of electrons from atom to atom. Where there are, as in (13) of Fig. 19, a number of electrons involved in the circuit, loss of the circulatory energy by radiation will be exceedingly slow and the molecule will be a stable combination.

We believe that, where the molecular currents are very large and of the proper form, they give rise to the paramagnetic effects of such substances as iron. An example is the magnetic oxide of iron, Fe_3O_4 In this molecule 8 electrons whirl out of each atom of iron, and 6 electrons whirl out of each oxygen atom. The total number of electrons entering into the several circulatory exchanges of this molecule is 48, a comparatively large number.

This ends our discussion of valencies, while (1) to (8) of Fig. 19 provide an easy means of accurately remembering their distinct effect and value.

PART III.—OTHER EVIDENCE BEARING UPON THE THEORETICAL ATOM.

There are some further interesting facts and experiments which bear upon the theory set forth, to wit:

First. Atoms must ordinarily bound off from one another when they collide. It seems that, complimenting gravitation, and like gravitation an invariable accompaniment of mass, and of the order of gravitation, there must be acting between all masses at very short range a force of repulsion varying inversely as the third or higher power of the intervening distances.

Second. Rutherford's experiments with ionized helium atoms, in the form of positively charged alpha particles shot through thin metal foils, show that a very rapidly moving atom passes right on through another atom, not its own size, which it encounters in its path; and does no more damage than to knock a few electrons out of the sluggard and to suffer some deflection of its course. A careful measurement of the deflection *seems* to show that at the center of each atom is a very small positive nucleus whose charge measured in electron units, is equal to the integral number of the atom's atomic weight. These experiments deal rather hardly with the large positive sphere type of atom. It would seem that every part of an atom would have to be of rather small dimensions to be able to get out of the way fast enough from an oncoming helium atom "running on high" at 10,000 miles a second. However, we believe that the *positive ring and electron* group atom answers the test. Furthermore, by the immediate-force-field law assumed, the positive ring of the trespassed atom would act toward the positive ring of the helium atom just as if they were both minute nuclei at their respective centers.

Third. Although the mass of an atom is about 1800 times an electron's mass for each unit of atomic weight, there is strong experimental evidence to suggest that the number of *active* electrons in the atom must be equal to, and *can not exceed,* just one electron for each unit of atomic weight. The positive ring and electron group atom has for its *total* number of electrons—and they are certainly *active*—this integral number of the atomic weight.

Fourth. It has been found through masterful calculations by Sir J. J. Thomson and later confirmed by experiment that the mass of a moving electric charge increases from the minimum existent in the charge at rest, to infinity, if the moving charge should ever arrive at the speed of light.

PRIZE FOR RADIO TO THE PLANETS.

Interstellar wireless is so staggering a proposition that it makes most of us gasp or smile, but M. Pierre Guzman of Paris, France, has offered a $20,000 prize for the first astronomical telegrapher who will establish communication with any planet except Mars; the exclusion of Mars should make it an almost mathematical certainty that the 100,000 francs will remain in M. Guzman's possession for some time to come. Still the Martians might give us some valuable tips of how to build canals without slides.

(Mr. Guzman excluded Mars as a matter of course, so as not to interfere with our friend Münchhausen! !—Editor.)

EMERGENCY LIGHTS ON PASSENGER BOATS.

A number of passenger vessels at Baltimore, Md., have been equipped with emergency lights, using the emergency radio storage battery as an auxiliary source of power to operate them. The auxiliary power furnished for the wireless telegraph is thus made to serve for emergency lighting.

RADIO CLUB ACTIVITIES.

(Continued from page 172)

communication to the secretary, C. A. Coe, at the Y.M.C.A., or to 311 Baronne Street, New Orleans, La.

The Signal Corps Regiment of the New York State Division of the United Boys' Brigades of America, a military organization with companies in various churches, is working on a *preparedness idea* and asks the cooperation of the radio amateurs and novices of Brooklyn, Queens and Nassau counties to make this idea an actual fact.

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(Continued on page 215)

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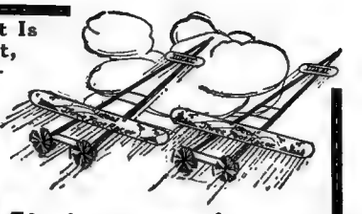

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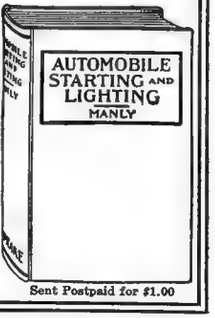

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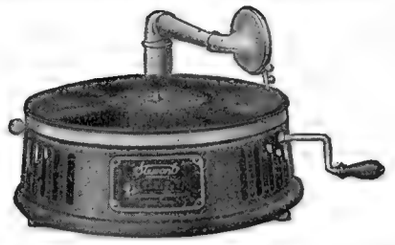

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This explains the excess mass of an atom over and above that carried by its comparatively quiescent electrons; for, in order that the positive nucleus of the atom shall become an extended ring, instead of the minute spherical body—driven in upon itself by its own reaction in the ether—which it would otherwise be, it is necessary to assume that the nucleus, or ring, is rotating very rapidly at perhaps not far short of the velocity of light; and is thus sustained in ring formation by its own centrifugal effort. The electromagnetic or moving mass of such a ring would reach a high figure depending upon its velocity of rotation; and it seems that this figure is about 1800 times the minimum or resting mass of the ring's charge.

On the other hand, the terrific rotation of the positive ring will probably not produce any sensible magnetic field beyond a most minute distance from itself, because of the near continuity of the positive charge.

Fifth. Radioactivity. There are three primary types of theoretical views in regard to the electronic atom. These are: first, the "solar system" atom having a minute positive nucleus or central "sun" around which electrons revolve in miniature orbits; second, the positive-sphere atom within which electrons may be distributed at rest in concentric shells, or in rotation as a plane group; and third, the rotating positive ring and inside plane group of electrons of the type which we have discussed. The first of the above types is incapable of even beginning to give a real explanation of radioactivity the author believes, because the splitting up of the positive mass, which radioactivity demands, cannot be seen in the "solar system" atom's case to proceed from any adequate cause provided in the latter's nucleus. The second type, the positive-sphere atom, cannot furnish the explanation unless the positive sphere be set in rapid rotation, and then it would not remain a positive sphere, but would become a positive ring. The rotating-positive-ring atom, alone, has an adequate cause in its own great centrifugal force for an occasional radioactive explosion. This would occur under such external conditions as would impose severe distortion or a lack of external counteracting pressure upon the ring.

From these theoretical considerations and from the astronomical and spectroscopically observed fact that the oldest and most condensed suns have present in them the heaviest elements, it seems certain that the atoms observe a certain general equilibrium with respect to the pressures under which they are formed. Owing to the mutual inverse third or higher power of distance repulsion of masses, a body of small atoms at even absolute zero temperature will occupy more space than the same mass condensed into larger atoms. Therefore, as the pressure of a star mass increases, the initial small atoms will be coalesced into larger atoms, able to withstand that pressure. Then, afterward, if the pressure be removed, the large atom will try to expand back to its original state, and will become like a violent leashed explosive, awaiting only the proper impulse to rupture the continuity of its fiercely revolving ring and to throw off a portion which becomes the new atom ejected in the process of radioactivity. It is, in all, a simple case where the kinetic energy of ring rotation has increased under certain favorable conditions at the expense of potential energy; and now under certain other conditions radioactivity shows the excess of the ring rotation's kinetic energy reverting back to potential energy, in part, and to kinetic dissipation in heat.

The case is not yet well enough set forth to venture any definite conjecture as to just what is the nature of the impulse which, like the fulminating cap and fuse at the base of an explosive, sets off the unstable energy of a radioactive atom. The geometric-progression law of radioactive disintegration seems to indicate that the impulse, whatever it may be, is in a manner accidental; just as the explosion of any particular one of a large number of little piles of ammonium iodide in a room full of flies would be an accident depending upon which pile a fly happened to alight. We are inclined to believe that the impulse comes from within the atom rather than from without and that it has its immediate origin in some unusual disturbance of the electron group, such as an excessively rapid or *eccentric* rotation of the latter. In this connection it is a very peculiar and significant point that, of all of the possible electron groups and consequent atoms which we should expect to exist, only a few have survived some age-old process of selection; and these, as shown in the floating-magnets experiments, are the ones possessing the largest amount of ring-form *symmetry* and having in most cases *even numbers* of electrons in the rings. There are mysteries yet to explore.

We will give some weights and measurements of the elements in the sub-microscopic universe from which we now emerge.

The mass of an electron is from 86 to 100 and upward, depending upon its velocity, one one-hundred-octillionths of a gram. Its negative electric charge is 4.89 one ten-billionths of an electrostatic unit. The mass of a hydrogen atom is about 162,000, one-hundred-octillionths of a gram, and this is about 1800 times the mass of an electron. The masses of other atoms are to the mass of the hydrogen atom as the ratios of their respective atomic weights. There are about 27 quintillion, 500 quadrillion molecules in a cubic centimeter of hydrogen gas under atmospheric pressure and at 0° Centigrade, or about 615 sextillion, 700 quintillion atoms in a gram of hydrogen under the same conditions.

The End.

WATER WHEEL DRIVES FOR PRIVATE LIGHTING PLANTS.

(*Continued from page 181*)

In designing and building water wheels there is quite a wide latitude, and there is of course nothing gained by constructing a wheel of twice the necessary size or vice versa. A simple design suitable for amateur construction is shown at Fig. 1.

The overshot water wheel here illustrated is not a relic of early days, but a modern home-made wheel, built by Mr. Arthur Scott of Woronoco, Mass., to furnish him with power for several home tasks. The wheel is 14 ft. in diameter and drives a 100 volt generator, which furnishes sufficient electricity for lighting fifteen 16 candle-power lamps in his home. He also uses the wheel to furnish power for running the laundry, sawing wood and turning a grindstone.

As aforementioned, the *overshot* type of water wheel is the most desirable to use when possible, as it is the most efficient. In this design of wheel a small amount of the work is done by the impact of the water as it enters the buckets (see Fig. 2), but the major portion is accomplished by the weight of the water as it descends in the buckets. For the reason that only one-half of the energy due to the velocity of the entering body of water proves efficient by the force of impact, the velocity of entry for an overshot wheel is usually made as small as becomes consistent with a proper filling of the buckets. Hence it is preferable to consider the head that produces

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the velocity of entry a small fractional part only of the total head, the greater part of which is taken up by the diameter of the wheel.

Referring to Figs. 2 and 4, we see that the water from the lake or stream is led through a flume constructed of boards or concrete. A sluice gate controls the amount of water supplied to the wheel buckets as becomes evident. The depth of water in the flume should not exceed 8 to 10 inches on the average. The sluice opening is provided with an iron or wooden lip, which guides the stream of water into the buckets. It should be so designed that the water will enter the first, second or third bucket from the vertical center line of the wheel. Note the extended sides of the flume at A, on either side of the wheel, which serve the purpose of retaining the water in the buckets, especially when starting the wheel. The outer rim of the wheel B, known as the *crown*, rotates close up to the sluice opening.

To begin with the initial design factor is the peripheral velocity, V_1, of the rim of the wheel. It ranges from 2½ to 3 feet per second in small wheels up to 10 feet per second for the larger ones. The total fall H (see Fig. 2), determines the diameter

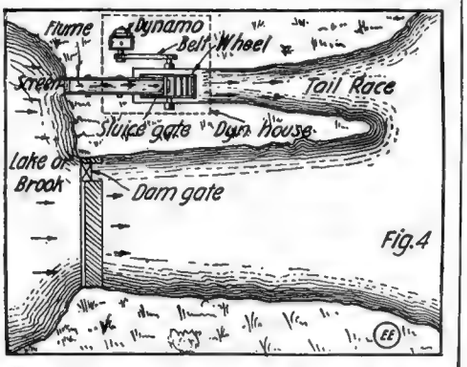

Fig. 4. Suggested Lay-Out of Water Wheel Plant, Including Dam, Flood and Sluice Gates, Screen, Tail Race, and Dynamo.

D, of the wheel, as also the factor H_1, or the head required to produce the desired velocity of entry V_e of the water into the buckets. As the velocity of entry V_e is always higher than the velocity of the rim of the wheel, its value may be ascertained directly from the formula:

$$V_e = 1.75 \times V_1$$

There are of course frictional losses encountered by the water flowing through the flume and gate, and it is well to use the following expression to calculate the head H_1, necessary to produce the entry velocity V_e:

$$H_1 = 1.1 \frac{V_e^2}{2g} = 1.1 \frac{V_e^2}{64.32}$$

Knowing these values the diameter, D, of the wheel is found by deducting H_1 from H, and considering the requisite clearance between the wheel and the sluice lip S_1. The speed of the wheel in revolutions per minute (R.P.M.) is dependent upon the peripheral velocity V_1, and the diameter D in feet, and may be computed as follows:

$$\text{R. P. M.} = \frac{60 \times V_1}{\pi D} = \frac{60 \times V_1}{3.1416 \times D}$$

It is usual to figure the total number of buckets, B_N as equal to 2.5 to 3 times D (the latter expressed in feet), and the depth, d, of the buckets from 8 to 15 inches; depending upon the size of the wheel. The breadth of the buckets, b, should be

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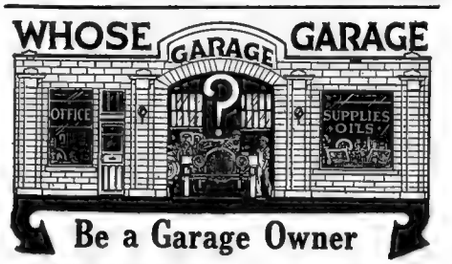

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so proportioned that they will be only partly filled, in order that they may retain the water as long as possible. The formula here cited for the breadth value, b, may be used:

$$b = 3.5 \frac{Q}{d \times V_1}$$

In which b is the breadth of the bucket in feet, d their depth in feet, and Q the quantity of water in cubic feet per second supplied to the wheel. Where the width b of the buckets or wheel is more than 3 to 4 feet, it is found advisable to insert a third or fourth crown X (see Fig. 3). This relieves the strain on each bucket. In building a water wheel it is imperative to see that the buckets are evenly and accurately spaced around the crown rings B, B. Moreover, if the highest efficiency is desired the buckets must be carefully designed in order that the water will enter them freely, and with little shock, besides being retained as long as practicable.

For those who wish to build simply a small wheel, without delving into lengthy calculations, the bucket design shown at Fig. 3 B, may be utilized. Here, knowing the number of buckets, it is an easy matter to construct a template in the manner indicated. The angle of the wooden bucket, also its height at the bottom are given. Ordinarily these buckets are secured partly by means of wooden strips, nailed or screwed to the inside of the wooden crown rings B, B (Fig. 2); white pine or oak proves serviceable for the woodwork throughout. They should be at least ¾" thick and are sometimes faced with tin or galvanized iron. Some builders prefer to use steel buckets and where it is convenient to bend or form from ⅛" or thicker sheet iron or steel, advantage may be taken of the more efficient shape of bucket illustrated at Fig. 3 A. The ends of the iron buckets may be lapped over and drilled to facilitate their mounting, or they are in some cases mortised into wooden rims. Metal rims and buckets, riveted together, make a first-class job.

Proceeding to the design of metal buckets as outlined at Fig. 3 A, the curved line A—B is first drawn, forming a parabolic curve. It corresponds to the path taken by a projectile when ejected horizontally (as shown in Fig. 3 C) with a velocity equivalent to the velocity of entry into the buckets V_e.

Referring to Fig. 3 C, A represents the starting point of the projectile (an iron ball, for instance) and assuming for example that it is shot horizontally toward the right with a velocity of say 80 feet per second, then succeeding increments for the 2nd, 3rd, 4th and 5th seconds are as shown. The horizontal as well as the vertical lines I, J, K, L, etc., are laid off on a corresponding scale. The effect of gravity on the projectile or moving body is to pull it downward at the rate of 16.08 feet in the first second; 64.32 feet at the end of the second second, etc. The distance through which a body falls in a certain time in seconds is:

$$h = \tfrac{1}{2} g t^2 = \tfrac{1}{2} \times 32.16 \times t^2$$

where :—h is height in feet fallen through; t, the time in seconds body is falling.

In Fig. 3 C, lay off the vertical distance A—I to represent 16.08 feet (drawn to scale); complete the parallelogram A 1 B I, when B will represent the point the projectile has reached at the end of the first second's travel. Repeat the operation; obtaining in turn the points C, D, E, etc., and a curve passing through these points is found to be a parabola. Distance A—J= 64.32 feet; A—K=144.72 feet, etc.

Resuming the discussion of Fig. 3 A, the arc C—E is drawn with a radius R, equal to ½ D; D being the diameter of the wheel in feet. This cuts the parabola at a, resulting in the distance e, which is equal to ½ the thickness of the flume bottom, and plus the clearance between the crown of the wheel and the sluice way. Arc F—G of the crown rim is drawn from the same center. From where this arc cuts the parabola at point b, draw a straight line A b, marking the point a^1, at which A b intersects the crown arc C E. Next draw arc m c, from b as a center with a radius d (depth of a bucket). Draw the *radial* line c f, outlining next the shape of a bucket a^1 f, using the radius $r = a^1 b$. Mark off the distance c g to equal ½ l, l being the distance between the points a and a^1. Line g h is now drawn in parallel to c f. Finally join the curve $a^1 f$, and the line g h, with an arc whose radius is equal to l. We now have the outline of an efficient bucket, and by means of a sheet iron pattern or template, all the other buckets are laid out and formed. The pitch t of the buckets is ascertained by dividing the outer circumference of the wheel by the number of buckets. Likewise the sole pitch t_1.

The complete wheel is illustrated partly in section at Fig. 2, and the spokes are very well formed of 2 by 4 inch timber for ordinary size wheels, say up to 15 feet diameter. For small wheels, the cross bracing K need not be used. It strengthens the rotating mass greatly however. The arrangement of the hub and spokes is optional and several schemes are suggested in Fig. 3 at D, E and F. At D and E, the idea is to use a discarded steel wagon axle, which being square at the center enables us to clamp it securely between two pieces of heavy timber grooved out as Figs. 3 D and E, indicate. The two hub timbers may be bolted together as at D, or clamped together as E shows, where use is made of two wrought iron clamps, bolted together. As becomes manifest, it is now an easy matter to build up the frame-work of the wheel. Another spoking scheme appears at Fig. 3 F. This calls for two circular iron plates, to which the wooden spokes are bolted. Two heavy iron rings are also bolted to the spokes and plates and a stout steel pin passed through them secures the circular (cold rolled machine steel) shaft quite solidly.

Several details regarding the buckets are illustrated at G and H, Fig. 3. The *sole* and crown rims B, B, Fig. 2, are usually nailed or screwed together. To render the bucket section more rigid, iron tie rods (⅜" wrought iron stock, threaded on both ends) are generally passed through spokes, crown rims and all. The wheel should be so laid out so that these tie rods come against the back of a bucket, and not in the center of the bucket opening. A better scheme is seen at H, Fig. 3, in which two ⅛" or 3/16" iron plates are placed on the outside of the spokes at the top, and the tie rod is then passed through the spokes only, and not through the buckets. The crown rims are secured to the spokes by *blind* or countersunk bolts as shown. In building such structures as this, care must be exercised in squaring up the spokes so that they are exactly at right angles to the shaft. A carpenter's steel square will help in this work, but a 90° template should be made with a length equal to the radius of the wheel. Use the same size lumber throughout on any certain parts so as to *balance* the structure as well as possible.

Referring to Figs. 2 and 4, the general installation features will be apparent. The first part of this paper considered the quan-

tity of water necessary per minute to develop one horsepower, etc. It is best, and in fact usual, to make the flume 40 to 50 per cent. larger than theoretically calculated as the quantity of water supplied the wheel can be governed by the sluice gate opening used. The latter is sometimes regulated automatically by a fly-ball governor attached to the water wheel; the sluice opening being reduced when the speed exceeds a certain predetermined value and vice versa.

The flume is commonly made of planking, but concrete makes an excellent one also. Extended splash boards, A, prevent undue waste of water and to boost the efficiency still more, an iron or wooden apron, M, may be secured to pipe supports, and in this manner the water will be partially prevented from leaving the buckets before they have reached their lower or emptying point. As the weight of the water in the buckets is the most important factor in the production of useful work by the wheel, it is seen that this and other refinements are actually worth while.

It is best to line the *tail race,* where the water leaves the buckets , with concrete, as Fig. 2 shows. For small wheels developing 5 to 10 horsepower, it is permissible to support the journals, etc., in standard shaft-hangers, available on the open market from any machine supply dealer. A belt drive pulley may be mounted directly on the shaft as shown, and in this way any speed ratio, for driving a dynamo or other apparatus, may be obtained. The dynamo only may be enclosed, or the wheel, dynamo and switchboard can be housed in, as the building outline suggested in Fig. 3 indicates.

As an example of a waterwheel designed after the rules here given, the following data may prove interesting: The design in question is for a consumption of 10 cu. ft. of water per second or 600 cu. ft. per minute. The total head is 25 feet. The peripheral velocity of the crown 8 ft. per second; velocity of entry $V_e = 2V_1$ and the head necessary to produce the velocity of entry or H_1, is equal to $1.1 \times \frac{16''}{64.32}$ or 4.38 feet. Assuming H_1 is 4 feet, the wheel diameter D is 25 minus 4 or 21 feet. The number of buckets, B_N may be 2.5xD or 52, and the resultant bucket pitch on the outer crown periphery—15.218 inches. Making the depth, d, of the buckets 12 inches, the breadth, b, can be $3 \times \frac{Q}{dV_1}$ or $\frac{3 \times 10}{8 \times 1} = 3.75$ feet. The speed in R.P.M. by the formula previously cited is found to be 7.28 R.P.M.

Figuring on 25 feet total head, 37,500 lbs. of water consumed by the wheel per minute and 70 per cent. gross efficiency, the horsepower H.P. developed will be:

$$H.P. = \frac{25 \times 37{,}500}{33{,}000} \times .70 = 19.88 \text{ effective H.P.}$$

In the next paper the manner of wiring up the dynamo, switch-board, distribution circuits, determination of size of wire, etc., will be taken up. Also how far low voltage lines can be run.

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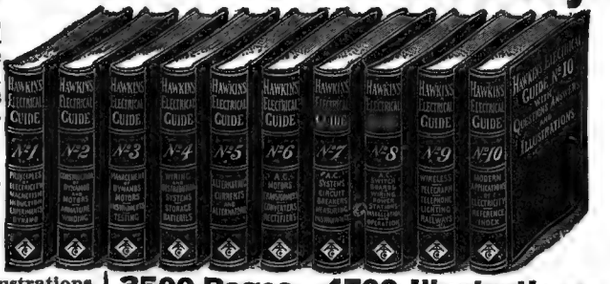

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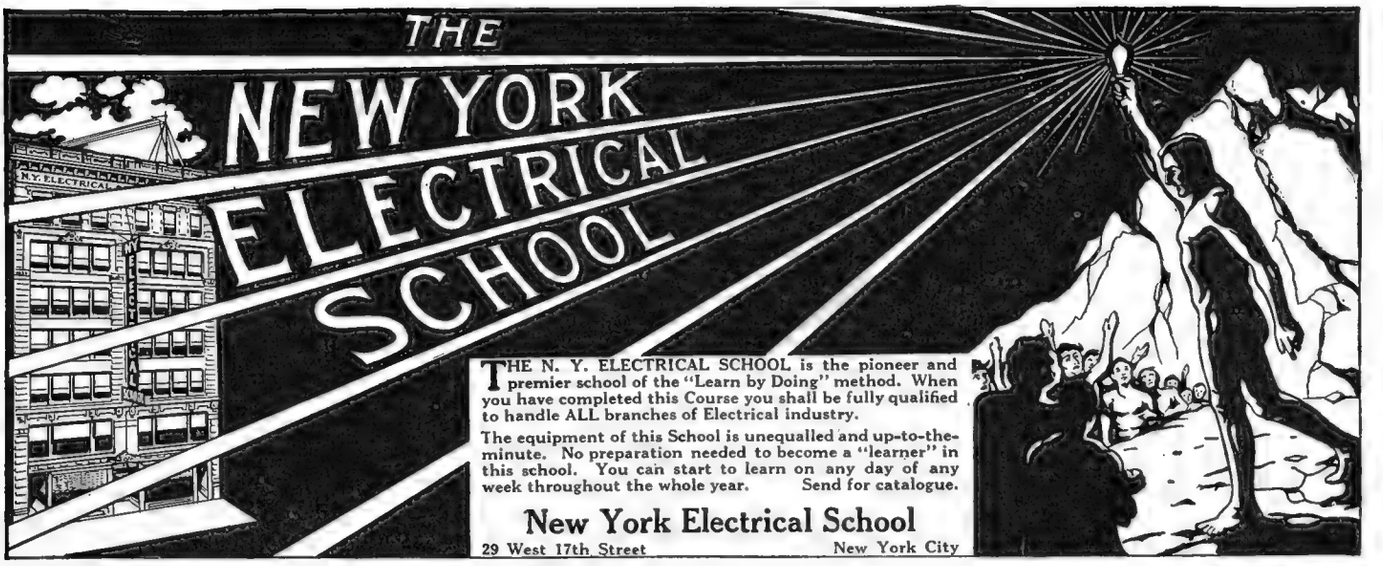

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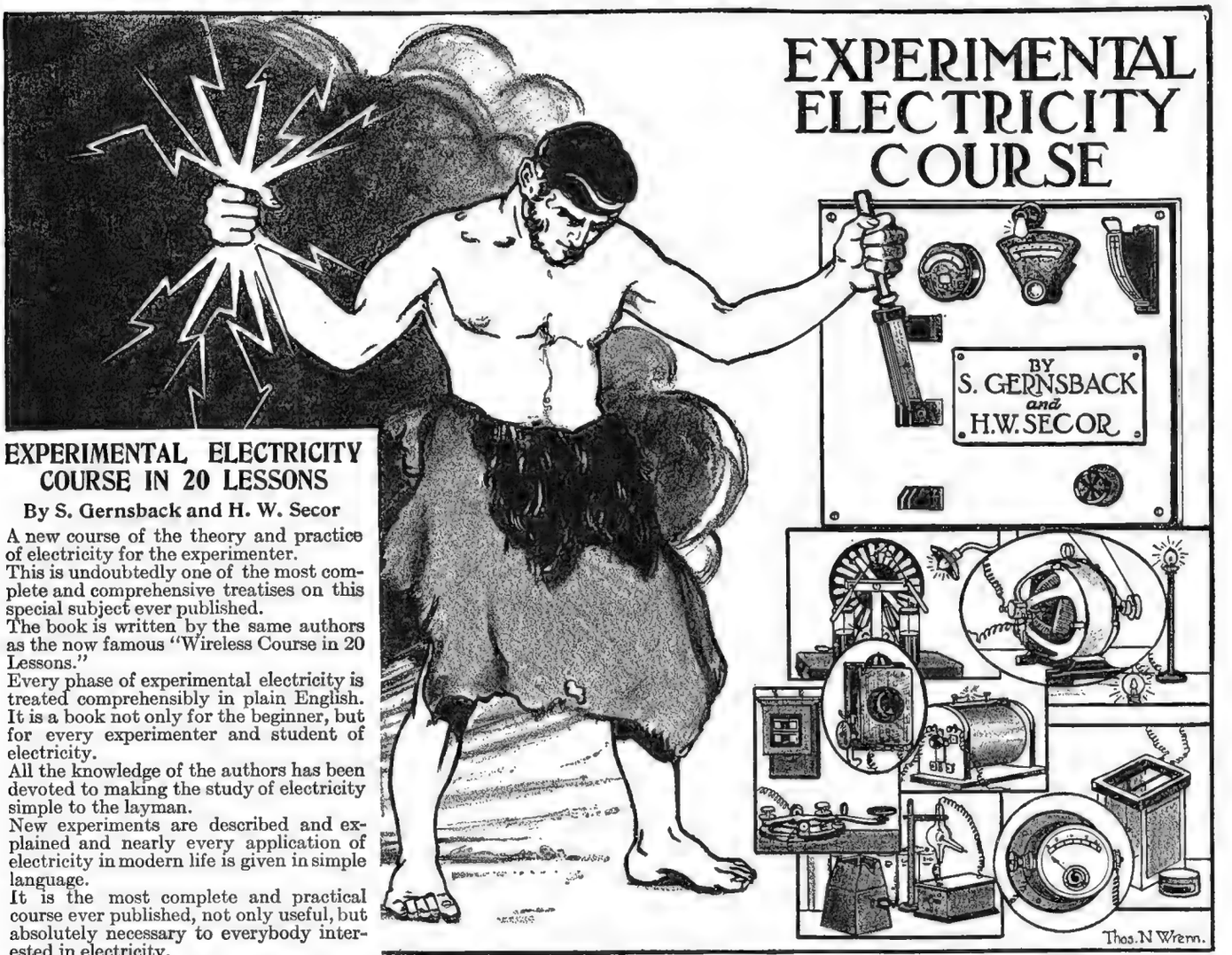

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(*Continued from page 209*)

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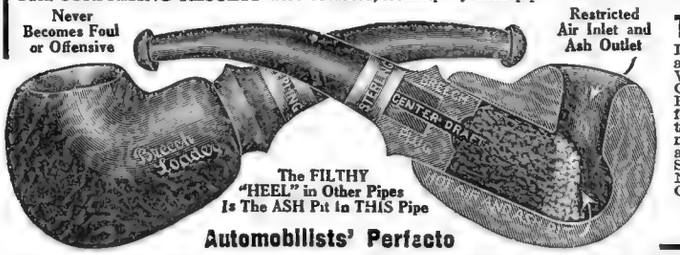
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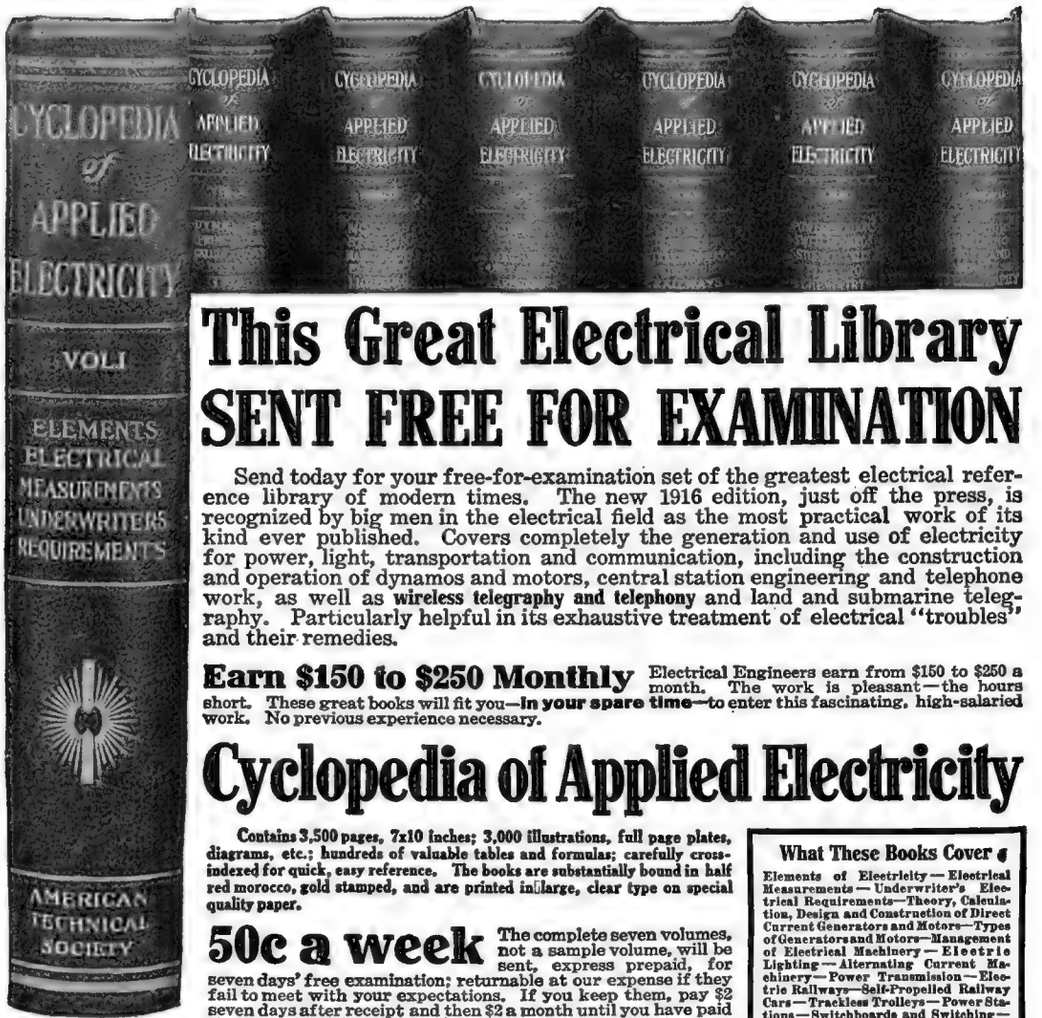

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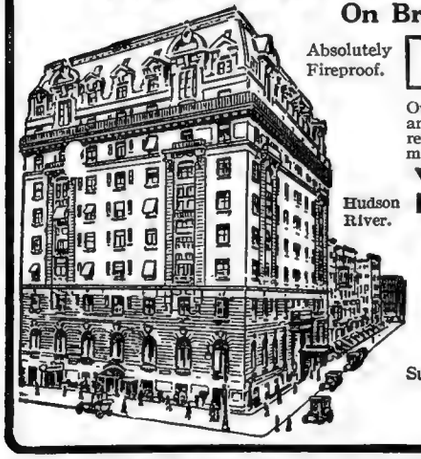

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technical work and the various phases of social life and recreation, that we feel there must be many lovers of wireless who would greatly appreciate being one of the organization. Instead of sending etheric "nothings" to a friend a few blocks, or a few miles, away, you may become an active member of a progressive organization that already has many of your fellows enrolled and is part of the great national organization of the United Boys' Brigades of America with branches in every state in the Union. At the same time you will have the great satisfaction of knowing that you are doing your "bit" as a true American toward putting your country in a better state of preparedness.

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The boys of the Radio Club of Irvington, N.J., gave a benefit performance at the Liberty Theater May second. The vice-president, W. G. Hunt, gave a brief demonstration on wireless telegraphy. A panel set, built and designed for Mr. Hunt by Harry L. Dearborn, a radio expert of Lincoln, N.H., was used and by means of the novel amplifying arrangement, the entire audience was enabled to hear the weather report and time signals as sent out from the Government station at Radio, Va. No telephone receivers were used except when the operator was tuning in at first. The novelty was well received by the audience and they were especially interested when told that this feat had never before been attempted in any theater. There were several in the audience who could read the signals, knowing the code fairly well, and they verified the weather report. The management has suggested that it be repeated later, because the rainy evening kept many away, although the boys were rewarded by having a good size house. An aerial 400 feet long and 64 feet high was constructed for the affair and a steam pipe served for the ground.

Address all communications to A. Bugg, Press Correspondent.

REVISED LIST OF AMATEUR RADIO CLUBS

(Addition to list published in May issue.)

Des Moines Radio Association, Des Moines Y.M.C.A., Iowa. Secretary, Ralph Knouf, 1344 Twenty-first Street, Des Moines, Iowa.

Hilton Wireless Club, Hilton, N.J. Secretary, Arthur Wester, Hilton, N.J.

Keystone Radio Club, Philadelphia, Pa. Secretary, Joe Jackson, 603 Spring Garden Street, Philadelphia, Pa.

Maple City Radio Club, Harnell, N.J. Secretary, Robert Schultz, 172 Main Street, Harnell, N.J.

Miami Wireless Association, Miami, Fla. Secretary, Howard Henshaw, Miami, Fla.

Parker Hill Radio Club, 10 Eldore Street, Roxbury, Mass. Secretary, Charles McAuly, Sachen Street, Roxbury, Mass.

Portland Radio Association, Congress Street, Portland, Me. Secretary, C. F. Beardsley, 20 Spruce Street, Portland, Me.

Radio Club of Framingham, Framingham, Mass. Secretary, J. Louis Reynolds, 20 Gordon Street, Framingham, Mass.

Radio Association of Ravenswood, Chicago, Ill. Secretary, Nick Smucyn, 1642 N. Wood Street, Chicago, Ill.

Radio Club of Wayne, Pa. Secretary, Perry H. Long, Wayne, Pa.

Reno Radio Club, Reno, Nev. Secretary, Aloysius Heer, 134 Marsh Avenue, Reno, Nev.

Trenton Y.M.C.A. Radio Club, 127 East State Street, Trenton, N.J. Secretary, Edward G. Raser, 921 Edgewood Avenue, Trenton, N.J.

Wichita Wireless Association, Butts Building, Wichita, Kan. Secretary, C. V. Williams, 525 N. Emporia Avenue, Wichita, Kan.

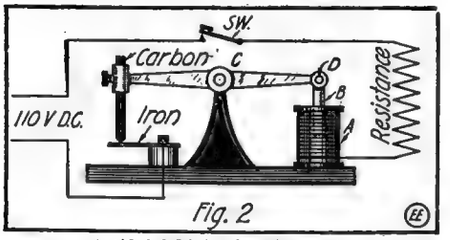
Ypsilanti Radio Amateurs, High School Building, Ypsilanti, Mich. Secretary, Karl Oehmke, 308 Brower Street, Ypsilanti, Mich.

Name of Club.....
Location (street and city).....
Founded .....
No. of Members.....
Meeting Date .....
Power of Club Set, if any.....
Call Letter (licensed?).....
Dues and Initiation Fee.....
Secretary's Name and Address.....

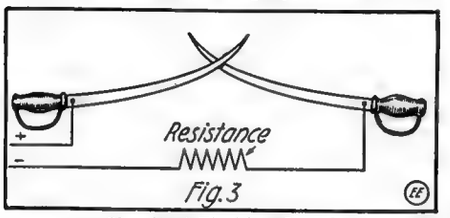
ELECTRICITY'S PART ON THE STAGE.

(*Continued from page 151*)

than it was ever thought possible for them to be accomplished. And to think that only thirty years ago the use of electricity on the stage was unheard of whether for lights or stunts. Surely as Josh Billings remarked: "The world do move" and electricity appears to be the moving force.



Artificial Lightning Apparatus



Circuit of Flashing Swords

TRAILING ARAVILLA.

(*Continued from page 171*)

mission on the Rio Grande. Join the scout squadron, Mr. Cawthorne. You'll be under Travers' orders, but he'll work with you."

* * *

Fifteen minutes afterwards the Gravitation Nullifier, G.N.3. carrying Cawthorne, Lieutenant Travers and the plane and wireless operators, was leading the aero squadron over to the Ixcatelec Gulch. Below them trotted six hundred troopers with three of the auto machine-guns.

As they approached the stupendous peaks of the Ixcatelec Mountains Cawthorne asked:—

"Have you any idea how that gulch runs, Lieutenant?"

"Only a general direction of northwest. But Berkhole's in that scout aero. He'll signal us as soon as he reaches it."

As he spoke they saw the scout aero change its direction and Berkhole, scanning through his binoculars the fearful tangle of peaks and chasms below. Suddenly he doubled back, steering a very irregular zig-zag course, evidently directly over the gulch. Then came his wireless call to Travers, and the message:—

"Plenty of trail signs. Enemy must have gone through to the mesa."

"Steer north, Chapman!" the Lieutenant ordered the operator. Then to the wireless man:—"Signal all to follow us!"

Then he turned to Cawthorne:—"My God, man! That big supply train is due across there now. Forty trucks, and almost all loaded with ammunition and we're short, Cawthorne; awfully short!"

"Full speed, Chapman!" grunted the young millionaire.

A mere speck ahead was Berkhole's aero, rounding a gigantic peak. The next moment Travers' man got a call:—

"Enemy attacking the supply train!"

There was no comment on that. The motors were rattling like the quickest Gatling ever operated, and for five minutes the speed was beyond estimation.

Three miles to the west was the long train of motor trucks, and galloping furiously towards them were the Mexicans. Chapman threw over his wheel and Cawthorne unfastened a bag containing the curious little metal pellets.

"Lieutenant! You scatter these when we get above those fellows. I'll have to attend to the Nullifier."

Travers nodded. "What are these, Cawthorne?"

"The attractors. They might be called, more scientifically, "Ground-Antennae" for

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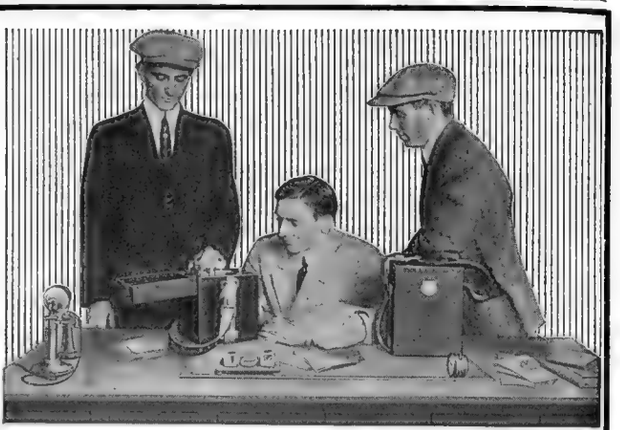

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they attract the current from our Nullifier, and anything that current passes loses all gravity. Look, Travers! Aren't those machine guns the Mexicans are getting into action?"

"Sure are, Cawthorne. Steer directly above them, Chapman!"

"And slow down!" added Cawthorne.

There was only the small operating group about each of those guns; the main force of the enemy drawing to the north and south from the line of fire, but closing up to the truck-train.

"Now!" shouted Cawthorne. "Scatter the Attractors, Travers! Toss them on each side!" and at the same moment he switched in the Nullifier.

There had been two or three turns of the machine-gun cranks and the hail of shot was reaching the truck-train when the G.N.3. glided over them. Instantly the group was in appalling confusion, although to the men in the gyroplane directly overhead, the astounding effects were not so clear as to men in the surrounding scout aeros.

They saw the Mexicans drifting in the air; skimming along the surface, their weight entirely gone, and the light breeze wafting them about as it would thistledown. The firing instantly stopped as the first gun, with the operator clinging frantically to it, drifted away before the breeze.

A moment later Cawthorne glided over the other gun, and as a sudden turn of the breeze caught it, it drifted against the first and entangled itself with that, while the gun crew went sailing, some heads down and colliding with other frantic howling greasers who were off their feet.

But the two main bodies of the enemy apparently paid no attention to the amazing catastrophe, for they closed together and made a furious rush on the supply train, being met by a fierce hail of bullets from the American escort and a storm of shrapnel from the three-inch gun on the armored car.

"Over there, Chapman!" shouted Cawthorne. Then to the wireless operator:—"Signal G.N.4. to circle round and cut off any fugitives!"

The next moment they were above the insurrectionists who were so close into the halted motor-trucks that Lieutenant Travers hesitated about tossing out the Attractor pellets.

"We'll catch our friends as well as the enemy, Cawthorne!"

"Go to it, Travers! It'll do no harm, and will stop the slaughter. Let 'em go. Now!"

Then ensued the most appalling experience that had ever come to those men; surpassing even that of shot and shrapnel at close range. Horses in the midst of a leap bounded into the air, struggling frantically for the earth again. Friend and foe felt it alike and the advance trucks, coming under the marvelous influence of the Gravitation Nullifier,

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and caught by the breeze, shifted from the trail like toy balloons and drifted across the greasewood.

Rifles, revolvers and sabres, relinquished by the fighters, floated about or settled softly to the ground. In place of the furious detonations of the machine guns and the smaller arms, came the yells, shrieks, imprecations and supplications of the helpless, weightless, aimless drifters, as they came in contact with and clutched each other in convulsive desperation, seeking for some anchorage.

"Steer off to one side, Chapman!" yelled Cawthorne. "Travers; they'll get their weight back as soon as we draw away, but we'll circle around them and hold 'em here. They'll not get their grit back in a hurry."

The lieutenant nodded and the two Nullifier Gyroplanes circled slowly around the big mob of Mexicans and Americans. But while the former were too paralyzed with terror and amazement to re-form and resume hostilities, the American troops, understanding the miracle which had happened, seized the handiest weapons and dashed amongst the enemy gathering up rifles and revolvers and smashing down any man who showed the slightest gleam of interference.

Then a grunt came from Travers, and looking in the direction he pointed, Cawthorne saw Captain Berchall's command galloping out from the mouth of the cañon,

"They're coming in good time to take charge of the prisoners and Aravilla, Lieutenant. Twelve hundred men! That's going some for three minutes' work!"

They circled around, keeping the Mexicans in a huddled, tangled mass until the troopers arrived. Then they glided to the earth and as they reached Captain Berchall they saw his features distorted with indescribable rage and disgust.

Aravilla had escaped!

"Lost out, again!" he growled with raging bitterness. "The only man we care for gets away,and leaves this bunch for us to feed! I'd exchange the whole damn lot for that one crafty, incorrigible devil, dead or alive!"

* * *

Two days later a wounded officer of Aravilla's horde was captured and brought in. He stated that his chief was dead from shots received in the attack on the motor-trucks; that he had seen him buried and gave a clear description of the location of the grave.

Cynically doubting, the General ordered a squad of men to search for it. It was up in the mountain range, within four miles of the miserable village of San Morajos, that they found the truth of the insurrecto's statement, and they brought the body into camp. Every one who had seen the rebel chief agreed that it was he and the following wireless was relayed to Washington:—

(*Continued on page 221*)

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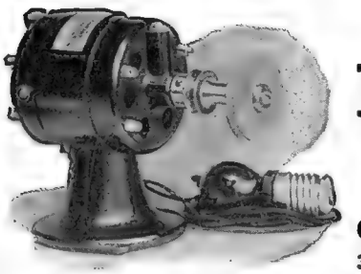

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Only strictly modern and up-to-date apparatus are described in this book, and if we asked you 50c for it, we are sure that you would think it a bargain. This book has been written by twenty radio experts who know how to make wireless sending apparatus and for that reason you profit by their experience as well as by their experiments.

Among others, this book contains the following important apparatus: How-to-Make an Experimental Arc Set, How-to-Make a Speaking Arc Light, How-to-Make a Quenched Spark Gap, How-to-Make a ¼ K. W. Transformer, How-to-Make an Oscillation Transformer, How-to-Make a Radio Break in System, How-to-Make a Photophone, How-to-Make a Rotary Spark Gap, How-to-Make an Independent Vibrator, How-to-Make a Calibrated Spark Gap, and many others.

Size of the book is 7 x 5 inches, substantially bound in paper; the cover being printed in two colors. There are 100 pages and 88 illustrations. There are quite a few full-page illustrations giving all dimensions as well as photographs showing finished apparatus.

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How to Make Wireless Sending Apparatus,

How to Make Wireless Receiving Apparatus

This book will surely be a boon to every "how-to-make-it" fiend. It has been written and published entirely for the wireless enthusiast who makes his own receiving apparatus and the twenty radio constructors who have written the articles are well-seasoned in the art and know whereof they speak. Consequently, you profit by their experience.

Only strictly up-to-date and modern apparatus are described and only those that the average experimenter can make himself, with material that can be readily obtained. We believe that **this book contains more information on how to make a wireless receiving apparatus than any other book in print** and you will find that it is easily worth double the price we are asking for it.

Among the many good articles, the following will be of particular interest: How-to-Make a Receiving Set Without Aerial or Ground, How-to-Build a Magnetic Detector, How-to-Make a Wireless Relay, How-to-Make a Wireless Lecture Set, Intensifying Radio Signals, Construction of an Improved Loose Coupler, How-to-Make a Conical Tuning Coil, Construction of an Interference Preventer, How-to-Make a Unique Receiving Transformer, Construction of an Efficient Wave Meter, How-to-Make a Pocket Wireless Set, etc., etc.

Size of the book is 7 x 5 inches, handsomely bound in paper; the cover being printed in two colors. There are 100 pages and 90 illustrations. There are quite a few full-page illustrations giving all dimensions as well as quite a few photographs showing the finished apparatus.

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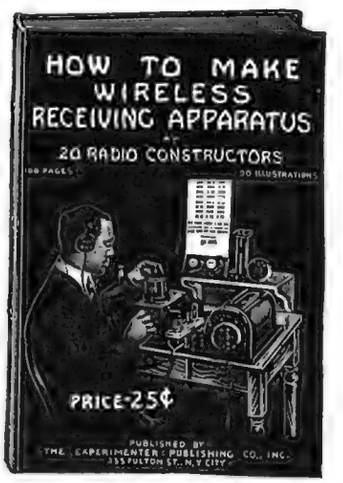
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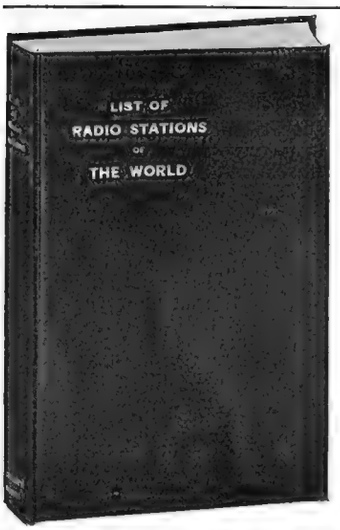

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The book was compiled by **FRANK A. HART, Chief Inspector of The Marconi Wireless Telegraph Co., of America,** and **H. M. SHORT, resident Inspector (U. S. A.), Marconi International Marine Communication Co., Ltd.** Need we say more as to the authority which these men have at their command to compile so noteworthy and necessary a book?

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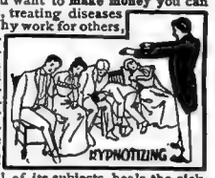

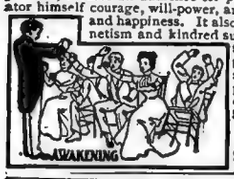

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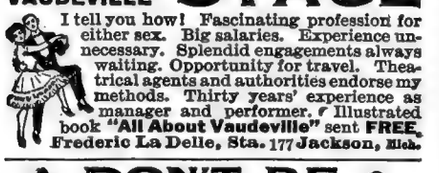

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TRAILING ARAVILLA.

(*Continued from page 219*)

"Have found Aravilla, dead and buried. Body brought to my headquarters. Will ship it to El Paso by return motor-truck train. Am awaiting orders as to prisoners.

"Forsythe,
"Commander in the field."

That night Berkhole, the scout, who understood the native language, had stolen up behind a clump of brush close to a small group of the prisoners to whom the man who had given the information about the grave was jubilantly telling a story. When Berkhole heard it he crept away; dashed to the General's tent and requested an audience.

As he repeated the story the officer strode back and forth with fury in his eyes and on his clenched jaws. He called for one of his staff officers:—

"Captain Sanderson! Have that Mexican informer brought here at once!"

But, as the Captain saluted and went through the entry the General called him back.

"Stay!"

"Captain! Have the fellow brought to your tent. There tell him to put his report in writing. I desire to send it back to Washington. Get that report, Captain! No matter how. Get it!"

Then to an orderly:—"Direct Professor Gunzri and Mr. Cawthorne to come here immediately!"

When Captain Sanderson returned to the General's tent, Gunzri and Cawthorne were there.

The General took the report. "This is in Spanish, Professor. Will you need a translation?"

"No, General. Chirography has its national characteristics, but pictures show the mind in a universally understood manner."

He slipped the paper into the Electromatograph and the picture appeared.

It was the interior of a large 'dobe house. Aravilla was there with a few unkempt but fully armed and uniformed men of whom the man who had brought in the information of the death and burial, was one. Before Aravilla stood a native, and although there was doubt and terror in his face and trembling limbs, his resemblance to the Insurrecto Chief brought a gasp of surprise from General Forsythe and his officers.

Aravilla stepped close to the man, savagely uplifted the downcast chin and peered into his face. He scrutinized the height of the man and the breadth of his shoulders; then stepped back a pace and a wicked, triumphant grin spread over his features.

He whipped out a revolver and put three shots into the poor wretch's body.

For a moment he glared at that body as it quivered on the floor. Then he stripped off his coat, hat and even his sword and they were exchanged, by his men, for the peon's ragged clothes.

The scene changed. The men were dumping the peon—clad in Aravilla's uniform—into a shallow grave. Then they and the chief darted to their horses and rode away.

"So!" muttered the General. "Killed that peon to impersonate himself, eh! Captain Sanderson? Place that informer before a firing squad and get his confession! Travers! Take a squad of men with fresh horses; overtake that motor-truck train and order that body thrown out and buried: Orderly! Take down this message for the wireless officer:—

"General Funston, Army Headquarters,
El Paso.

"Body of Aravilla was impersonated by a peon killed for the purpose. Aravilla still at large. Location unknown.

"Gen. L. G. Forsythe,
"Commander of Division in Chupaderas."

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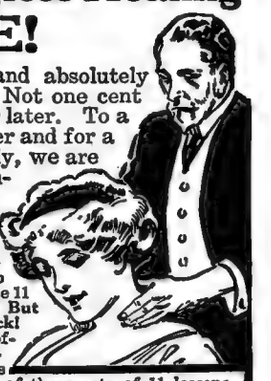

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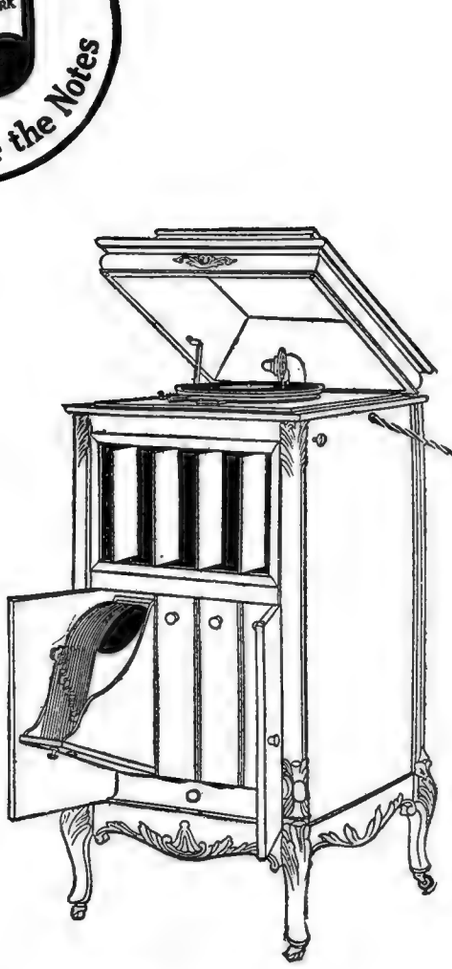

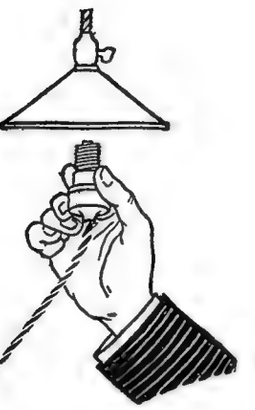

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SALE OR EXCHANGE—Cornet, standard make, nearly new. First offer that sounds reasonable takes it. Would like typewriter. L. W. Bliven, 237 Willetts Ave., New London, Conn.

WANTED—To buy for cash a Clapp-Eastham ½ K.W. HYTONE Transmitting set. State age and condition and lowest cash price. O. Oehmen, 759 Franklin Ave., Brooklyn, N.Y.

HAVE 14"x18" MARBLE SWITCHBOARD—with five switches, voltmeter, ammeter. Wanted, Geissler tubes, Tesla coil or what have you? Sieger, 41 Wells Ave., Jamaica, L.I.

FOR SALE—$150 new Mignon RLC4 Special receiving set, $45. Wm. B. Duck, R-42 receiving set. Will set cheap. All inquiries answered promptly. W. C. Hutcheson, Wind Rock, Tenn.

WILL TRADE MANDOLIN or pay cash for telegraph sounders, relays or omnigraph. Send description. Address Rexford, 520 Second St., Albany, N.Y.

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TO EXCHANGE—Wireless and electrical apparatus for motorcycle, gasoline engine, lathe, motorcycle magneto, V belt clutch. Joe Tustison, Yates Center, Kans.

WILL TRADE—Chambers' Rotary Spark Gap in solid oak case, for a good visible typewriter or what have you? Eben W. Erikson, Winnetka, Ill.

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FOR SALE—Wireless Transformer, in polished wood case, variable from ten to thirty-five amperes; $45 takes it. R. R. Ridgely, Rocky Ford, Colo.

FOR SALE—"Electro" Junior tuner, lead peroxide and galena detectors, rotary potentiometer and 75 ohm receiver; also 2000 ohm headset. Write for prices. Walter Glover, Newtown, Conn.

BARGAINS!—Brandes Superior set $4 "Electro" 1305 receiver, $2; charging cutout, $2.60; No. 810 dynamo, $6; Mesco motor, 40c.; Crystaloi (used 12 hours), $2.50; model aeroplane, 50c.; magic lantern, $2.25; back numbers of E.E. and *Popular Electricity;* resonator, 75c.; also 5 radio construction and 20 mechanical story books, radioson (new), $3.90. Want Blitzen 3-inch coil, long wave loaders and guaranteed supersensitive vacuum bulb, cheap vest-pocket camera, all new or O.K. Write Edwin Puls, Hoskins, Neb.

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AUDIO TRON BULBS—Two new, two filament, bulbs for sale. Good oscillators, $5 each. H. I. Goodale, 676 Elm St., Buffalo, N.Y.

FOR SALE OR EXCHANGE—Cabinet receiving set, sending apparatus, dynamo. Want ¼ K.W. Winger, Murdock condensers. John Spetzman, Powers Lake, Wis.

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LOOSE COUPLER for sale—1800 meter, 8 tap secondary, working fine, $4. Adrian Kishpaugh, Newton, N.J.

LOOSE COUPLER—silicon detector, condenser, 1000 ohm receiver, loading coil, Gernsback variable, new, value $16, sell $8.50. Schwarzburg, 1019 Kentucky St., Quincy, Ill.

FOR SALE OR EXCHANGE—Complete small photo outfit, does good work, invoice $6. Acetylene radiopticon, good as new, cost $9. Want gasoline engine, any kind; job press, typewriter, electrical apparatus or any kind of tools. Alger books for Tarzan books or text books. Walter Bennett, Route 2, Montevallo, Mo.

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FOR SALE—Large stamp album and collection, $1.75; and large receiving set, $5. Willard Harer, 1945 N. 18th St., Philadelphia, Pa.

FOR SALE—1200 meter Loose Coupler, new cost $6, will sell for $4; 5000 meter loading inductance, $1.65; lytic detector stand complete, 60c.; adjustable sending condenser, $1.50; helix, 65c. All letters answered. Thomas Cumming, Sound Beach, Conn.

FOR SALE—½ H.P. 220 volt series wound motor, could be used as generator, $12; 4½ H.P. single cylinder motorcycle engine complete with carburetor, muffler and spark coil, $15. Bench speed lathe, $5. Fred Bodington, 275 Goddard Ave., Bridgeport, Conn.

BARGAIN—1 Murdock $6 loose coupler, $3; 1 fixed condenser, 25c.; short throw aerial switch and two snap switches, 75c.; Omnigraph (handle type), $1.25. R. Shanahan, 964 E. 227nd St., Bronx, New York City.

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FOR SALE—2 3500 meter Navy type loose couplers, $6 each, Holtzer-Cabot headset 3000 Ohms, $6. Knapp S.S. dynamo, $2.50. 1" Mesco coil $3.50, D.P.D.T. 250 V. 100 A. switch $1.50, lightning switch 50c, 700 ft. antenium wire, insulators, etc., $2.00. E. Myers, 499 So. 21st St., Irvington, N.J.

WANTED—Large spark coil, transformer, head receivers and small A.C. motor, also field glasses, automatic pistol and musical instruments. Douglas Warwick, 5819 Race Ave., Austin, Ill.

MY AD in the May Experimenter is still good yet. Write Louis E. Krieg, 134 North School St., Gloversville, N.Y.

FOR SALE—Sending and receiving. Particulars on request. Roger Hernandez, 1506 Chew Street, Allentown, Penna.

WANTED—Blitzen or high grade, large Variometer in exchange for complete Multi-Audi-Fone in fine condition. J. H. Newton, Suffolk, Va.

LOOK!—Savage New Model '14, 22 calibre repeating rifle, equipped with Maxim Silencer and Lyman Peep Sight; complete $13. Will exchange for wireless apparatus. E. T. Mutersbaugh, R.D.1, Box 35, E. Falls Church, Va.

FOR SALE—$50 Meccano set with No. 2 motor and mahogany chest, $25; $7 transformer, $6; 75c. spark gap, 30c.; $2 key, $1.25; home-made glass plate condenser, 50c. All in good condition. ALL for $33. Russell Sceli, 404 Farmington Ave., Hartford, Conn.

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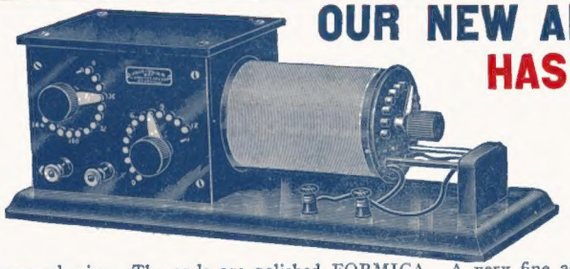

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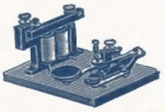

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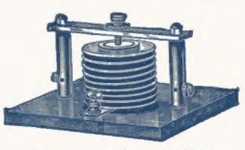

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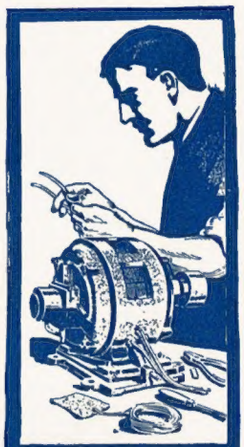

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